US009229571B2

(12) United States Patent
Ciesla et al.

(10) Patent No.: US 9,229,571 B2
(45) Date of Patent: Jan. 5, 2016

(54) **METHOD FOR ADJUSTING THE USER INTERFACE OF A DEVICE**

(71) Applicant: **Tactus Technology, Inc.**, Fremont, CA (US)

(72) Inventors: **Craig Ciesla**, Fremont, CA (US); **Micah Yairi**, Fremont, CA (US); **Nathaniel Mark Saal**, Fremont, CA (US)

(73) Assignee: **Tactus Technology, Inc.**, Fremont, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/054,527**

(22) Filed: **Oct. 15, 2013**

(65) **Prior Publication Data**

US 2014/0043291 A1 Feb. 13, 2014

Related U.S. Application Data

(63) Continuation of application No. 13/465,737, filed on May 7, 2012, now Pat. No. 8,587,548, which is a continuation of application No. 12/830,426, filed on Jul. 5, 2010, now Pat. No. 8,243,038.

(60) Provisional application No. 61/223,003, filed on Jul. 3, 2009, provisional application No. 61/303,214, filed on Feb. 10, 2010.

(51) **Int. Cl.**

G06F 3/01	(2006.01)
G06F 3/041	(2006.01)
G06F 3/044	(2006.01)

(52) **U.S. Cl.**

CPC ***G06F 3/0416*** (2013.01); ***G06F 3/016*** (2013.01); ***G06F 3/041*** (2013.01); ***G06F 3/044*** (2013.01); *G06F 2203/04103* (2013.01)

(58) **Field of Classification Search**

CPC G06F 2203/04809; G06F 3/04895; G06F 3/016; G06F 3/044; G06F 3/04883; G06F 3/04886; G06F 3/0414; H01H 2215/046; G09B 21/003–21/004

USPC 345/156–184; 178/18.01–20.04; 273/457–458; 434/113–114

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,034,628	A	5/1962	Wadey
3,659,354	A	5/1972	Sutherland

(Continued)

FOREIGN PATENT DOCUMENTS

CN	1260525	A	7/2000
CN	1530818	A	9/2004

(Continued)

OTHER PUBLICATIONS

"Sharp Develops and Will Mass Produce New System LCD with Embedded Optical Sensors to Provide Input Capabilities Including Touch Screen and Scanner Functions," Sharp Press Release, Aug. 31, 2007, 3 pages, downloaded from the Internet at: http://sharp-world.com/corporateinews/070831.html.

(Continued)

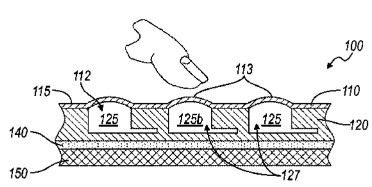
Primary Examiner — Patrick F Marinelli

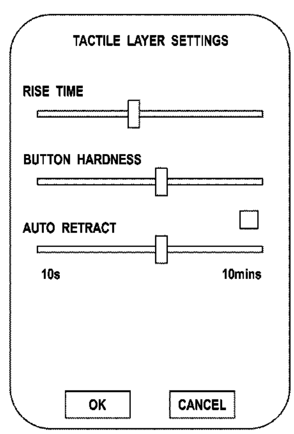
(74) *Attorney, Agent, or Firm* — Jeffrey Schox

(57) **ABSTRACT**

A method adjusting a user interface experience for a device that includes providing a user interface to retrieve a user input, providing a tactile interface layer that defines a surface and includes a volume of fluid and a displacement device **10** that manipulates the volume of fluid to deform a particular region of the surface into a tactilely distinguishable formation retrieving a user preference between a first type, location, and/or timing and a second embodiment, location, and/or timing through the user interface, and manipulating the volume of fluid to deform a particular region of the surface into a tactilely distinguishable formation of one of the first and second type, location, and/or timing is disclosed.

15 Claims, 9 Drawing Sheets





(56) **References Cited**

U.S. PATENT DOCUMENTS

3,759,108	A	9/1973	Borom et al.	
3,780,236	A	12/1973	Gross	
3,818,487	A	6/1974	Brody et al.	
4,109,118	A	8/1978	Kley	
4,209,819	A	6/1980	Seignemartin	
4,290,343	A	9/1981	Gram	
4,307,268	A	12/1981	Harper	
4,467,321	A	8/1984	Volnak	
4,477,700	A	10/1984	Balash et al.	
4,517,421	A	5/1985	Margolin	
4,543,000	A	9/1985	Hasenbalg	
4,584,625	A	4/1986	Kellogg	
4,700,025	A	10/1987	Hatayama et al.	
4,772,205	A	9/1988	Chlumsky et al.	
4,920,343	A	4/1990	Schwartz	
4,940,734	A	7/1990	Ley et al.	
5,194,852	A	3/1993	More et al.	
5,195,659	A	3/1993	Eiskant	
5,212,473	A	5/1993	Louis	
5,222,895	A *	6/1993	Fricke	G09B 21/003 340/407.1
5,286,199	A	2/1994	Kipke	
5,369,228	A	11/1994	Faust	
5,412,189	A	5/1995	Cragun	
5,459,461	A	10/1995	Crowley et al.	
5,488,204	A	1/1996	Mead et al.	
5,496,174	A *	3/1996	Garner	G09B 21/003 434/113
5,666,112	A	9/1997	Crowley et al.	
5,717,423	A	2/1998	Parker	
5,729,222	A	3/1998	Iggulden et al.	
5,742,241	A	4/1998	Crowley et al.	
5,754,023	A	5/1998	Roston et al.	
5,766,013	A	6/1998	Vuyk	
5,767,839	A	6/1998	Rosenberg	
5,835,080	A	11/1998	Beeteson et al.	
5,880,411	A	3/1999	Gillespie et al.	
5,889,236	A	3/1999	Gillespie et al.	
5,917,906	A	6/1999	Thornton	
5,943,043	A	8/1999	Furuhata et al.	
5,977,867	A	11/1999	Blouin	
5,982,304	A	11/1999	Selker et al.	
6,067,116	A	5/2000	Yamano et al.	
6,154,198	A	11/2000	Rosenberg	
6,154,201	A	11/2000	Levin et al.	
6,160,540	A	12/2000	Fishkin et al.	
6,169,540	B1	1/2001	Rosenberg et al.	
6,187,398	B1 *	2/2001	Eldridge	A47B 23/002 108/43
6,188,391	B1	2/2001	Seely et al.	
6,218,966	B1 *	4/2001	Goodwin	G06F 3/016 200/5 A
6,243,074	B1	6/2001	Fishkin et al.	
6,243,078	B1	6/2001	Rosenberg	
6,268,857	B1	7/2001	Fishkin et al.	
6,271,828	B1	8/2001	Rosenberg et al.	
6,278,441	B1	8/2001	Gouzman et al.	
6,300,937	B1	10/2001	Rosenberg	
6,310,614	B1	10/2001	Maeda et al.	
6,323,846	B1	11/2001	Westerman et al.	
6,337,678	B1	1/2002	Fish	
6,354,839	B1 *	3/2002	Schmidt	G09B 21/003 434/112
6,356,259	B1	3/2002	Maeda et al.	
6,359,572	B1	3/2002	Vale	
6,366,272	B1	4/2002	Rosenberg et al.	
6,369,803	B2	4/2002	Brisebois et al.	
6,384,743	B1	5/2002	Vanderheiden	
6,414,671	B1	7/2002	Gillespie et al.	
6,429,846	B2	8/2002	Rosenberg et al.	
6,437,771	B1	8/2002	Rosenberg et al.	
6,462,294	B2	10/2002	Davidson et al.	
6,469,692	B2	10/2002	Rosenberg	
6,486,872	B2	11/2002	Rosenberg et al.	
6,498,353	B2	12/2002	Nagle et al.	
6,501,462	B1	12/2002	Garner	
6,509,892	B1	1/2003	Cooper et al.	
6,529,183	B1	3/2003	MacLean et al.	
6,573,844	B1	6/2003	Venolia et al.	
6,636,202	B2	10/2003	Ishmael, Jr. et al.	
6,639,581	B1	10/2003	Moore et al.	
6,655,788	B1	12/2003	Freeman	
6,657,614	B1	12/2003	Ito et al.	
6,667,738	B2	12/2003	Murphy	
6,681,031	B2	1/2004	Cohen et al.	
6,683,627	B1 *	1/2004	Ullmann	G06F 3/038 715/786
6,686,911	B1	2/2004	Levin et al.	
6,697,086	B2	2/2004	Rosenberg et al.	
6,700,556	B2	3/2004	Richley et al.	
6,703,924	B2	3/2004	Tecu et al.	
6,743,021	B2	6/2004	Prince et al.	
6,788,295	B1	9/2004	Inkster	
6,819,316	B2	11/2004	Schulz et al.	
6,850,222	B1	2/2005	Rosenberg	
6,861,961	B2	3/2005	Sandbach et al.	
6,877,986	B2	4/2005	Fournier et al.	
6,881,063	B2	4/2005	Yang	
6,930,234	B2	8/2005	Davis	
6,937,225	B1	8/2005	Kehlstadt et al.	
6,975,305	B2	12/2005	Yamashita	
6,979,164	B2	12/2005	Kramer	
6,982,696	B1	1/2006	Shahoian	
6,995,745	B2	2/2006	Boon et al.	
7,027,032	B2	4/2006	Rosenberg et al.	
7,056,051	B2 *	6/2006	Fiffie	B43K 29/00 40/905
7,061,467	B2	6/2006	Rosenberg	
7,064,655	B2	6/2006	Murray et al.	
7,079,111	B2 *	7/2006	Ho	G06F 3/03547 345/156
7,081,888	B2	7/2006	Cok et al.	
7,096,852	B2	8/2006	Gregorio	
7,102,541	B2	9/2006	Rosenberg	
7,104,152	B2	9/2006	Levin et al.	
7,106,305	B2	9/2006	Rosenberg	
7,106,313	B2	9/2006	Schena et al.	
7,109,967	B2	9/2006	Hioki et al.	
7,112,737	B2	9/2006	Ramstein	
7,113,166	B1	9/2006	Rosenberg et al.	
7,116,317	B2	10/2006	Gregorio et al.	
7,124,425	B1	10/2006	Anderson, Jr. et al.	
7,129,854	B2	10/2006	Arneson et al.	
7,131,073	B2	10/2006	Rosenberg et al.	
7,136,045	B2	11/2006	Rosenberg et al.	
7,138,977	B2	11/2006	Kinerk et al.	
7,138,985	B2	11/2006	Nakajima	
7,143,785	B2	12/2006	Maerkl et al.	
7,144,616	B1	12/2006	Unger et al.	
7,148,875	B2	12/2006	Rosenberg et al.	
7,151,432	B2	12/2006	Tierling	
7,151,527	B2	12/2006	Culver	
7,151,528	B2	12/2006	Taylor et al.	
7,154,470	B2	12/2006	Tierling	
7,158,112	B2	1/2007	Rosenberg et al.	
7,159,008	B1	1/2007	Wies et al.	
7,161,276	B2	1/2007	Face	
7,161,580	B2	1/2007	Bailey et al.	
7,168,042	B2	1/2007	Braun et al.	
7,176,903	B2	2/2007	Katsuki et al.	
7,182,691	B1	2/2007	Schena	
7,191,191	B2	3/2007	Peurach et al.	
7,193,607	B2	3/2007	Moore et al.	
7,195,170	B2	3/2007	Matsumoto et al.	
7,196,688	B2	3/2007	Schena	
7,198,137	B2	4/2007	Olien	
7,199,790	B2	4/2007	Rosenberg et al.	
7,202,851	B2	4/2007	Cunningham et al.	
7,205,981	B2	4/2007	Cunningham	
7,208,671	B2	4/2007	Chu	
7,209,028	B2	4/2007	Boronkay et al.	
7,209,113	B2	4/2007	Park	
7,209,117	B2	4/2007	Rosenberg et al.	
7,209,118	B2	4/2007	Shahoian et al.	

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,210,160 B2	4/2007	Anderson, Jr. et al.	
7,215,326 B2	5/2007	Rosenberg	
7,216,671 B2	5/2007	Unger et al.	
7,218,310 B2	5/2007	Tierling et al.	
7,218,313 B2	5/2007	Marcus et al.	
7,233,313 B2	6/2007	Levin et al.	
7,233,315 B2	6/2007	Gregorio et al.	
7,233,476 B2	6/2007	Goldenberg et al.	
7,236,157 B2	6/2007	Schena et al.	
7,245,202 B2	7/2007	Levin	
7,245,292 B1	7/2007	Custy	
7,249,951 B2	7/2007	Bevirt et al.	
7,250,128 B2	7/2007	Unger et al.	
7,253,803 B2	8/2007	Schena et al.	
7,253,807 B2	8/2007	Nakajima	
7,265,750 B2	9/2007	Rosenberg	
7,280,095 B2	10/2007	Grant	
7,283,120 B2	10/2007	Grant	
7,283,123 B2	10/2007	Braun et al.	
7,283,696 B2	10/2007	Ticknor et al.	
7,289,106 B2	10/2007	Bailey et al.	
7,289,111 B2	10/2007	Asbill	
7,307,619 B2	12/2007	Cunningham et al.	
7,308,831 B2	12/2007	Cunningham et al.	
7,319,374 B2	1/2008	Shahoian	
7,336,260 B2	2/2008	Martin et al.	
7,336,266 B2	2/2008	Hayward et al.	
7,339,572 B2	3/2008	Schena	
7,339,580 B2	3/2008	Westerman et al.	
7,342,573 B2	3/2008	Ryynaenen	
7,355,595 B2	4/2008	Bathiche et al.	
7,369,115 B2	5/2008	Cruz-Hernandez et al.	
7,382,357 B2	6/2008	Panotopoulos et al.	
7,390,157 B2	6/2008	Kramer	
7,391,861 B2	6/2008	Levy	
7,397,466 B2	7/2008	Bourdelais et al.	
7,403,191 B2	7/2008	Sinclair	
7,432,910 B2	10/2008	Shahoian	
7,432,911 B2	10/2008	Skarine	
7,432,912 B2	10/2008	Cote et al.	
7,433,719 B2	10/2008	Dabov	
7,471,280 B2	12/2008	Prins	
7,489,309 B2	2/2009	Levin et al.	
7,511,702 B2	3/2009	Hotelling	
7,522,152 B2	4/2009	Olien et al.	
7,545,289 B2	6/2009	Mackey et al.	
7,548,232 B2	6/2009	Shahoian et al.	
7,551,161 B2	6/2009	Mann	
7,561,142 B2	7/2009	Shahoian et al.	
7,567,232 B2	7/2009	Rosenberg	
7,567,243 B2	7/2009	Hayward	
7,589,714 B2	9/2009	Funaki	
7,592,999 B2	9/2009	Rosenberg et al.	
7,605,800 B2	10/2009	Rosenberg	
7,609,178 B2	10/2009	Son et al.	
7,656,393 B2	2/2010	King et al.	
7,659,885 B2	2/2010	Kraus et al.	
7,671,837 B2	3/2010	Forsblad et al.	
7,679,611 B2	3/2010	Schena	
7,679,839 B2	3/2010	Polyakov et al.	
7,688,310 B2	3/2010	Rosenberg	
7,701,438 B2	4/2010	Chang et al.	
7,728,820 B2	6/2010	Rosenberg et al.	
7,733,575 B2	6/2010	Heim et al.	
7,743,348 B2	6/2010	Robbins et al.	
7,755,602 B2	7/2010	Tremblay et al.	
7,808,488 B2	10/2010	Martin et al.	
7,834,853 B2	11/2010	Finney et al.	
7,843,424 B2	11/2010	Rosenberg et al.	
7,864,164 B2	1/2011	Cunningham et al.	
7,869,589 B2	1/2011	Tuovinen	
7,890,257 B2	2/2011	Fyke et al.	
7,890,863 B2	2/2011	Grant et al.	
7,920,131 B2	4/2011	Westerman	
7,924,145 B2	4/2011	Yuk et al.	
7,944,435 B2	5/2011	Rosenberg et al.	
7,952,498 B2	5/2011	Higa	
7,956,770 B2	6/2011	Klinghult et al.	
7,973,773 B2	7/2011	Pryor	
7,978,181 B2	7/2011	Westerman	
7,978,183 B2	7/2011	Rosenberg et al.	
7,978,186 B2	7/2011	Vassallo et al.	
7,979,797 B2	7/2011	Schena	
7,982,720 B2	7/2011	Rosenberg et al.	
7,986,303 B2	7/2011	Braun et al.	
7,986,306 B2	7/2011	Eich et al.	
7,989,181 B2	8/2011	Blattner et al.	
7,999,660 B2	8/2011	Cybart et al.	
8,002,089 B2	8/2011	Jasso et al.	
8,004,492 B2	8/2011	Kramer et al.	
8,013,843 B2	9/2011	Pryor	
8,020,095 B2	9/2011	Braun et al.	
8,022,933 B2	9/2011	Hardacker et al.	
8,031,181 B2	10/2011	Rosenberg et al.	
8,044,826 B2	10/2011	Yoo	
8,047,849 B2	11/2011	Ahn et al.	
8,049,734 B2	11/2011	Rosenberg et al.	
8,059,104 B2	11/2011	Shahoian et al.	
8,059,105 B2	11/2011	Rosenberg et al.	
8,063,892 B2	11/2011	Shahoian et al.	
8,063,893 B2	11/2011	Rosenberg et al.	
8,068,605 B2	11/2011	Holmberg	
8,077,154 B2	12/2011	Emig et al.	
8,077,440 B2	12/2011	Krabbenborg et al.	
8,077,941 B2	12/2011	Assmann	
8,094,121 B2	1/2012	Obermeyer et al.	
8,094,806 B2	1/2012	Levy	
8,103,472 B2	1/2012	Braun et al.	
8,106,787 B2	1/2012	Nurmi	
8,115,745 B2	2/2012	Gray	
8,123,660 B2	2/2012	Kruse et al.	
8,125,347 B2	2/2012	Fahn	
8,125,461 B2	2/2012	Weber et al.	
8,130,202 B2	3/2012	Levine et al.	
8,144,129 B2	3/2012	Hotelling et al.	
8,144,271 B2	3/2012	Han	
8,154,512 B2	4/2012	Olien et al.	
8,154,527 B2 *	4/2012	Ciesla	G06F 3/04886 178/18.01
8,159,461 B2	4/2012	Martin et al.	
8,162,009 B2	4/2012	Chaffee	
8,164,573 B2	4/2012	Dacosta et al.	
8,166,649 B2	5/2012	Moore	
8,169,306 B2	5/2012	Schmidt et al.	
8,169,402 B2	5/2012	Shahoian et al.	
8,174,372 B2	5/2012	Da Costa	
8,174,495 B2	5/2012	Takashima et al.	
8,174,508 B2	5/2012	Sinclair et al.	
8,174,511 B2	5/2012	Takenaka et al.	
8,178,808 B2	5/2012	Strittmatter	
8,179,375 B2	5/2012	Ciesla et al.	
8,179,377 B2	5/2012	Ciesla et al.	
8,188,989 B2	5/2012	Levin et al.	
8,195,243 B2	6/2012	Kim et al.	
8,199,107 B2	6/2012	Xu et al.	
8,199,124 B2	6/2012	Ciesla et al.	
8,203,094 B2	6/2012	Mittleman et al.	
8,203,537 B2	6/2012	Tanabe et al.	
8,207,950 B2	6/2012	Ciesla et al.	
8,212,772 B2	7/2012	Shahoian	
8,217,903 B2	7/2012	Ma et al.	
8,217,904 B2	7/2012	Kim	
8,223,278 B2	7/2012	Kim et al.	
8,224,392 B2	7/2012	Kim et al.	
8,228,305 B2	7/2012	Pryor	
8,232,976 B2	7/2012	Yun et al.	
8,243,038 B2 *	8/2012	Ciesla	G06F 3/016 178/18.01
8,253,052 B2	8/2012	Chen	
8,253,703 B2	8/2012	Eldering	
8,279,172 B2	10/2012	Braun et al.	
8,279,193 B1	10/2012	Birnbaum et al.	
8,310,458 B2	11/2012	Faubert et al.	
8,345,013 B2	1/2013	Heubel et al.	

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,350,820 B2 1/2013 Deslippe et al.
8,362,882 B2 1/2013 Heubel et al.
8,363,008 B2 1/2013 Ryu et al.
8,367,957 B2 2/2013 Strittmatter
8,368,641 B2 2/2013 Tremblay et al.
8,378,797 B2 2/2013 Pance et al.
8,384,680 B2 2/2013 Paleczny et al.
8,390,594 B2 3/2013 Modarres et al.
8,395,587 B2 3/2013 Cauwels et al.
8,395,591 B2 3/2013 Kruglick
8,400,402 B2 3/2013 Son
8,400,410 B2 3/2013 Taylor et al.
8,547,339 B2 10/2013 Ciesla
8,587,541 B2 * 11/2013 Ciesla G06F 3/016 340/407.1
8,587,548 B2 * 11/2013 Ciesla G06F 3/016 345/156
8,749,489 B2 6/2014 Ito et al.
2001/0008396 A1 7/2001 Komata
2001/0043189 A1 11/2001 Brisebois et al.
2002/0063694 A1 * 5/2002 Keely, Jr. G06F 3/0412 345/173
2002/0104691 A1 8/2002 Kent et al.
2002/0106614 A1 * 8/2002 Prince G09B 21/003 434/114
2002/0110237 A1 8/2002 Krishnan
2002/0149570 A1 10/2002 Knowles et al.
2002/0180620 A1 12/2002 Gettemy et al.
2003/0087698 A1 5/2003 Nishiumi et al.
2003/0117371 A1 6/2003 Roberts et al.
2003/0179190 A1 9/2003 Franzen
2003/0206153 A1 11/2003 Murphy
2003/0223799 A1 12/2003 Pihlaja
2004/0001589 A1 1/2004 Mueller et al.
2004/0056876 A1 3/2004 Nakajima
2004/0056877 A1 3/2004 Nakajima
2004/0106360 A1 6/2004 Farmer et al.
2004/0114324 A1 6/2004 Kusaka et al.
2004/0164968 A1 8/2004 Miyamoto
2004/0178006 A1 9/2004 Cok
2005/0007339 A1 1/2005 Sato
2005/0007349 A1 1/2005 Vakil et al.
2005/0020325 A1 1/2005 Enger et al.
2005/0030292 A1 2/2005 Diederiks
2005/0057528 A1 3/2005 Kleen
2005/0073506 A1 4/2005 Durso
2005/0088417 A1 4/2005 Mulligan
2005/0110768 A1 5/2005 Marriott et al.
2005/0162408 A1 7/2005 Martchovsky
2005/0212773 A1 9/2005 Asbill
2005/0231489 A1 10/2005 Ladouceur et al.
2005/0253816 A1 11/2005 Himberg et al.
2005/0270444 A1 12/2005 Miller et al.
2005/0285846 A1 * 12/2005 Funaki G06F 3/04886 345/173
2006/0026521 A1 2/2006 Hotelling et al.
2006/0087479 A1 4/2006 Sakurai et al.
2006/0097991 A1 5/2006 Hotelling et al.
2006/0098148 A1 5/2006 Kobayashi et al.
2006/0118610 A1 6/2006 Pihlaja et al.
2006/0119586 A1 6/2006 Grant et al.
2006/0152474 A1 7/2006 Saito et al.
2006/0154216 A1 7/2006 Hafez et al.
2006/0197753 A1 9/2006 Hotelling
2006/0214923 A1 9/2006 Chiu et al.
2006/0238495 A1 10/2006 Davis
2006/0238510 A1 * 10/2006 Panotopoulos G06F 3/0238 345/168
2006/0256075 A1 11/2006 Anastas et al.
2006/0278444 A1 12/2006 Binstead
2007/0013662 A1 1/2007 Fauth
2007/0036492 A1 2/2007 Lee
2007/0085837 A1 4/2007 Ricks et al.
2007/0108032 A1 5/2007 Matsumoto et al.
2007/0122314 A1 5/2007 Strand et al.
2007/0130212 A1 6/2007 Peurach et al.
2007/0152983 A1 7/2007 Mckillop et al.
2007/0165004 A1 7/2007 Seelhammer et al.
2007/0171210 A1 7/2007 Chaudhri et al.
2007/0182718 A1 8/2007 Schoener et al.
2007/0229233 A1 10/2007 Dort
2007/0229464 A1 * 10/2007 Hotelling G06F 3/044 345/173
2007/0236466 A1 10/2007 Hotelling
2007/0236469 A1 10/2007 Woolley et al.
2007/0247429 A1 10/2007 Westerman
2007/0254411 A1 11/2007 Uhland et al.
2007/0257634 A1 11/2007 Leschin et al.
2007/0273561 A1 11/2007 Philipp
2007/0296702 A1 12/2007 Strawn et al.
2007/0296709 A1 12/2007 Guanghai
2008/0010593 A1 1/2008 Uusitalo et al.
2008/0024459 A1 1/2008 Poupyrev et al.
2008/0054875 A1 3/2008 Saito
2008/0062151 A1 3/2008 Kent
2008/0136791 A1 6/2008 Nissar
2008/0138774 A1 * 6/2008 Ahn G09B 21/003 434/114
2008/0143693 A1 6/2008 Schena
2008/0150911 A1 6/2008 Harrison
2008/0165139 A1 7/2008 Hotelling et al.
2008/0174570 A1 7/2008 Jobs et al.
2008/0202251 A1 8/2008 Serban et al.
2008/0238448 A1 10/2008 Moore et al.
2008/0248836 A1 10/2008 Caine
2008/0251368 A1 10/2008 Holmberg et al.
2008/0252607 A1 10/2008 De Jong et al.
2008/0266264 A1 10/2008 Lipponen et al.
2008/0286447 A1 11/2008 Alden et al.
2008/0291169 A1 11/2008 Brenner et al.
2008/0297475 A1 12/2008 Woolf et al.
2008/0303796 A1 12/2008 Fyke
2009/0002140 A1 1/2009 Higa
2009/0002205 A1 1/2009 Klinghult et al.
2009/0002328 A1 * 1/2009 Ullrich G06F 3/016 345/173
2009/0002337 A1 1/2009 Chang
2009/0009480 A1 1/2009 Heringslack
2009/0015547 A1 * 1/2009 Franz H04M 19/04 345/156
2009/0028824 A1 * 1/2009 Chiang A61M 5/14248 424/85.7
2009/0033617 A1 2/2009 Lindberg et al.
2009/0066672 A1 3/2009 Tanabe et al.
2009/0085878 A1 4/2009 Heubel et al.
2009/0106655 A1 4/2009 Grant et al.
2009/0115733 A1 5/2009 Ma et al.
2009/0115734 A1 5/2009 Fredriksson et al.
2009/0128376 A1 5/2009 Caine et al.
2009/0128503 A1 * 5/2009 Grant G06F 3/016 345/173
2009/0129021 A1 5/2009 Dunn
2009/0132093 A1 5/2009 Arneson et al.
2009/0135145 A1 5/2009 Chen et al.
2009/0140989 A1 6/2009 Ahlgren
2009/0160813 A1 6/2009 Takashima et al.
2009/0167508 A1 7/2009 Fadell et al.
2009/0167509 A1 7/2009 Fadell et al.
2009/0167567 A1 7/2009 Halperin et al.
2009/0167677 A1 7/2009 Kruse et al.
2009/0167704 A1 7/2009 Terlizzi et al.
2009/0174673 A1 7/2009 Ciesla
2009/0174687 A1 7/2009 Ciesla et al.
2009/0181724 A1 7/2009 Pettersson
2009/0182501 A1 7/2009 Fyke et al.
2009/0195512 A1 8/2009 Pettersson
2009/0207148 A1 8/2009 Sugimoto et al.
2009/0215500 A1 8/2009 You et al.
2009/0231305 A1 * 9/2009 Hotelling G06F 3/044 345/174
2009/0243998 A1 10/2009 Wang
2009/0250267 A1 * 10/2009 Heubel G06F 3/041 178/18.03
2009/0289922 A1 11/2009 Henry

(56) **References Cited**

U.S. PATENT DOCUMENTS

2009/0303022	A1	12/2009	Griffin et al.	
2009/0309616	A1	12/2009	Klinghult	
2010/0043189	A1	2/2010	Fukano	
2010/0045613	A1	2/2010	Wu et al.	
2010/0073241	A1	3/2010	Ayala Vazquez et al.	
2010/0078231	A1*	4/2010	Yeh	G06F 3/044 178/18.05
2010/0079404	A1	4/2010	Degner et al.	
2010/0097323	A1*	4/2010	Edwards	G06F 3/041 345/173
2010/0103116	A1	4/2010	Leung et al.	
2010/0103137	A1	4/2010	Ciesla et al.	
2010/0109486	A1	5/2010	Polyakov et al.	
2010/0121928	A1	5/2010	Leonard	
2010/0141608	A1	6/2010	Huang et al.	
2010/0142516	A1	6/2010	Lawson et al.	
2010/0162109	A1	6/2010	Chatterjee et al.	
2010/0171719	A1*	7/2010	Craig	G06F 3/0202 345/173
2010/0171720	A1	7/2010	Craig et al.	
2010/0177050	A1*	7/2010	Heubel	G06F 3/0416 345/173
2010/0182245	A1*	7/2010	Edwards	G06F 3/041 345/173
2010/0232107	A1	9/2010	Dunn	
2010/0237043	A1	9/2010	Garlough	
2010/0295820	A1	11/2010	Kikin-Gil	
2010/0296248	A1	11/2010	Campbell et al.	
2010/0298032	A1	11/2010	Lee et al.	
2010/0302199	A1*	12/2010	Taylor	G06F 3/046 345/174
2010/0321335	A1	12/2010	Lim et al.	
2011/0001613	A1*	1/2011	Ciesla	G06F 3/016 340/407.2
2011/0011650	A1	1/2011	Klinghult	
2011/0012851	A1	1/2011	Ciesla et al.	
2011/0018813	A1	1/2011	Kruglick	
2011/0029862	A1	2/2011	Scott et al.	
2011/0043457	A1	2/2011	Oliver et al.	
2011/0060998	A1	3/2011	Schwartz et al.	
2011/0074691	A1	3/2011	Causey et al.	
2011/0120784	A1	5/2011	Osoinach et al.	
2011/0148793	A1	6/2011	Ciesla et al.	
2011/0148807	A1	6/2011	Fryer	
2011/0157056	A1	6/2011	Karpfinger	
2011/0157080	A1	6/2011	Ciesla et al.	
2011/0163978	A1	7/2011	Park et al.	
2011/0175838	A1	7/2011	Higa	
2011/0175844	A1	7/2011	Berggren	
2011/0181530	A1	7/2011	Park et al.	
2011/0193787	A1	8/2011	Morishige et al.	
2011/0241442	A1	10/2011	Mittleman et al.	
2011/0254672	A1	10/2011	Ciesla et al.	
2011/0254709	A1	10/2011	Ciesla et al.	
2011/0254789	A1	10/2011	Ciesla et al.	
2012/0032886	A1	2/2012	Ciesla et al.	
2012/0038583	A1	2/2012	Westhues et al.	
2012/0043191	A1	2/2012	Kessler et al.	
2012/0056846	A1	3/2012	Zaliva	
2012/0062483	A1	3/2012	Ciesla et al.	
2012/0080302	A1	4/2012	Kim et al.	
2012/0098789	A1	4/2012	Ciesla et al.	
2012/0105333	A1	5/2012	Maschmeyer et al.	
2012/0120357	A1	5/2012	Jiroku	
2012/0154324	A1	6/2012	Wright et al.	
2012/0193211	A1	8/2012	Ciesla et al.	
2012/0200528	A1*	8/2012	Ciesla	G06F 3/0202 345/174
2012/0200529	A1*	8/2012	Ciesla	G06F 3/0202 345/174
2012/0206364	A1	8/2012	Ciesla et al.	
2012/0218213	A1*	8/2012	Ciesla	G06F 3/016 345/173
2012/0218214	A1	8/2012	Ciesla et al.	
2012/0223914	A1	9/2012	Ciesla et al.	
2012/0235935	A1*	9/2012	Ciesla	G06F 3/0202 345/173
2012/0242607	A1	9/2012	Ciesla et al.	
2012/0306787	A1	12/2012	Ciesla et al.	
2013/0019207	A1	1/2013	Rothkopf et al.	
2013/0127790	A1	5/2013	Wassvik	
2013/0141118	A1	6/2013	Guard	
2013/0215035	A1	8/2013	Guard	
2014/0043291	A1*	2/2014	Ciesla	G06F 3/016 345/174
2014/0160063	A1	6/2014	Yairi et al.	
2014/0160064	A1	6/2014	Yairi et al.	

FOREIGN PATENT DOCUMENTS

CN	1882460	A	12/2006
JP	10255106		9/1998
JP	H10255106		9/1998
JP	2006268068	A	10/2006
JP	2006285785	A	10/2006
JP	2009064357	A	3/2009
KR	20000010511		2/2000
KR	100677624	B	1/2007
WO	2004028955	A	4/2004
WO	2008037275	A	4/2008
WO	2009002605	A	12/2008
WO	2009044027	A2	4/2009
WO	2009067572	A2	5/2009
WO	2009088985	A	7/2009
WO	2010077382	A	7/2010
WO	2010078596	A	7/2010
WO	2010078597	A	7/2010
WO	2011003113	A	1/2011
WO	2011087816	A	7/2011
WO	2011087817	A	7/2011
WO	2011112984	A	9/2011
WO	2011133604	A	10/2011
WO	2011133605	A	10/2011

OTHER PUBLICATIONS

Jeong et al., “Tunable Microdoublet Lens Array,” Optical Society of America, Optics Express; vol. 12, No. 11. May 31, 2004, 7 Pages.

Preumont, A. Vibration Control of Active Structures: An Introduction, Jul. 2011.

Essilor. “Ophthalmic Optic Files Materials,” Essilor International, Ser 145 Paris France, Mar. 1997, pp. 1-29, [retrieved on Nov. 18, 2014]. Retrieved from the internet. URL: <http://www.essiloracademy.eu/sites/default/files/9.Materials.pdf>.

Lind. “Two Decades of Negative Thermal Expansion Research: Where Do We Stand?” Department of Chemistry, the University of Toledo, Materials 2012, 5, 1125-1154; doi:10.3390/ma5061125, Jun. 20, 2012 pp. 1125-1154, [retrieved on Nov. 18, 2014]. Retrieved from the internet. URL: <https://www.google.com/webhp?sourceid=chrome-instant&ion=1&espv=2&ie=UTF-8#q=materials-05-01125.pdf>.

* cited by examiner

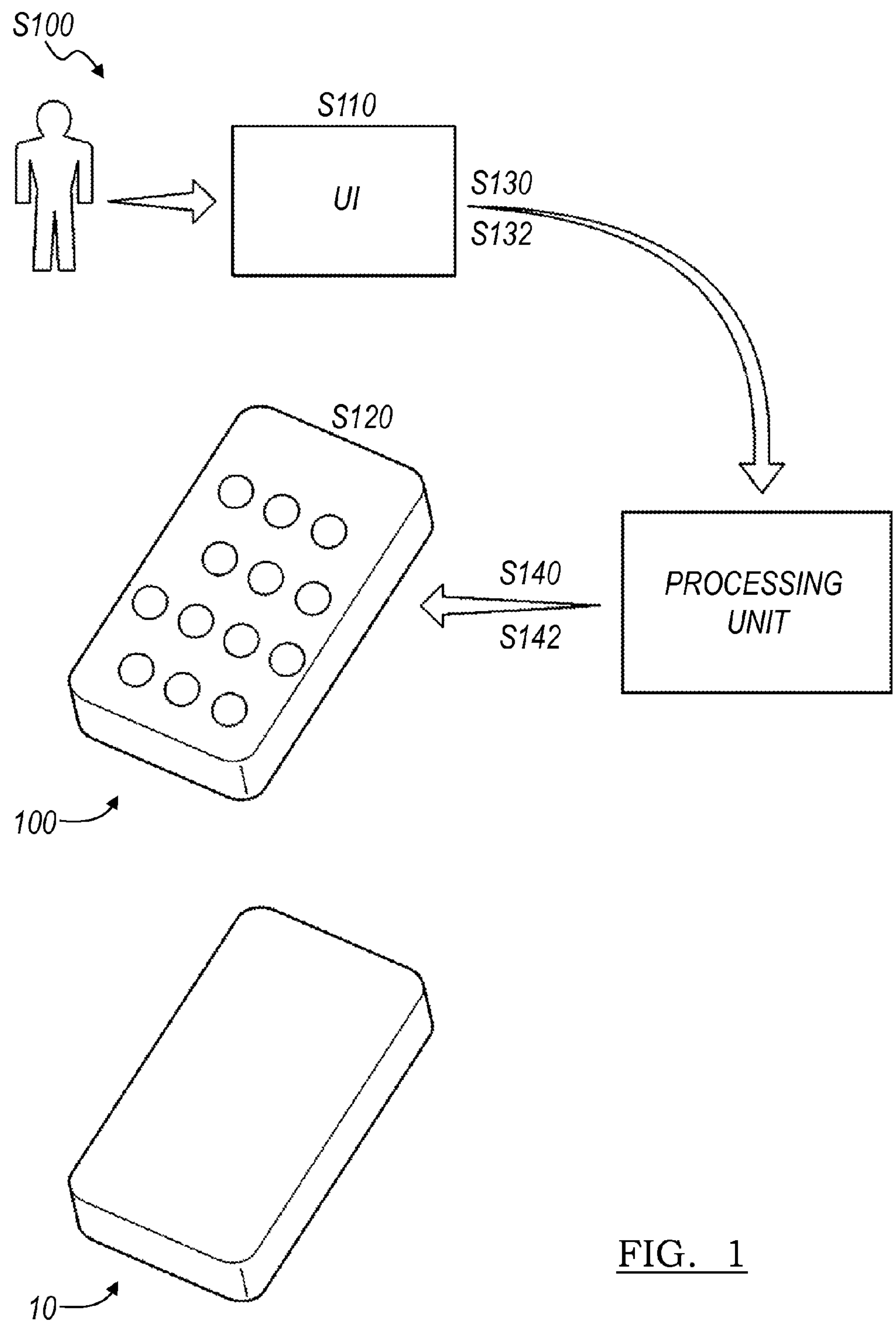


FIG. 1

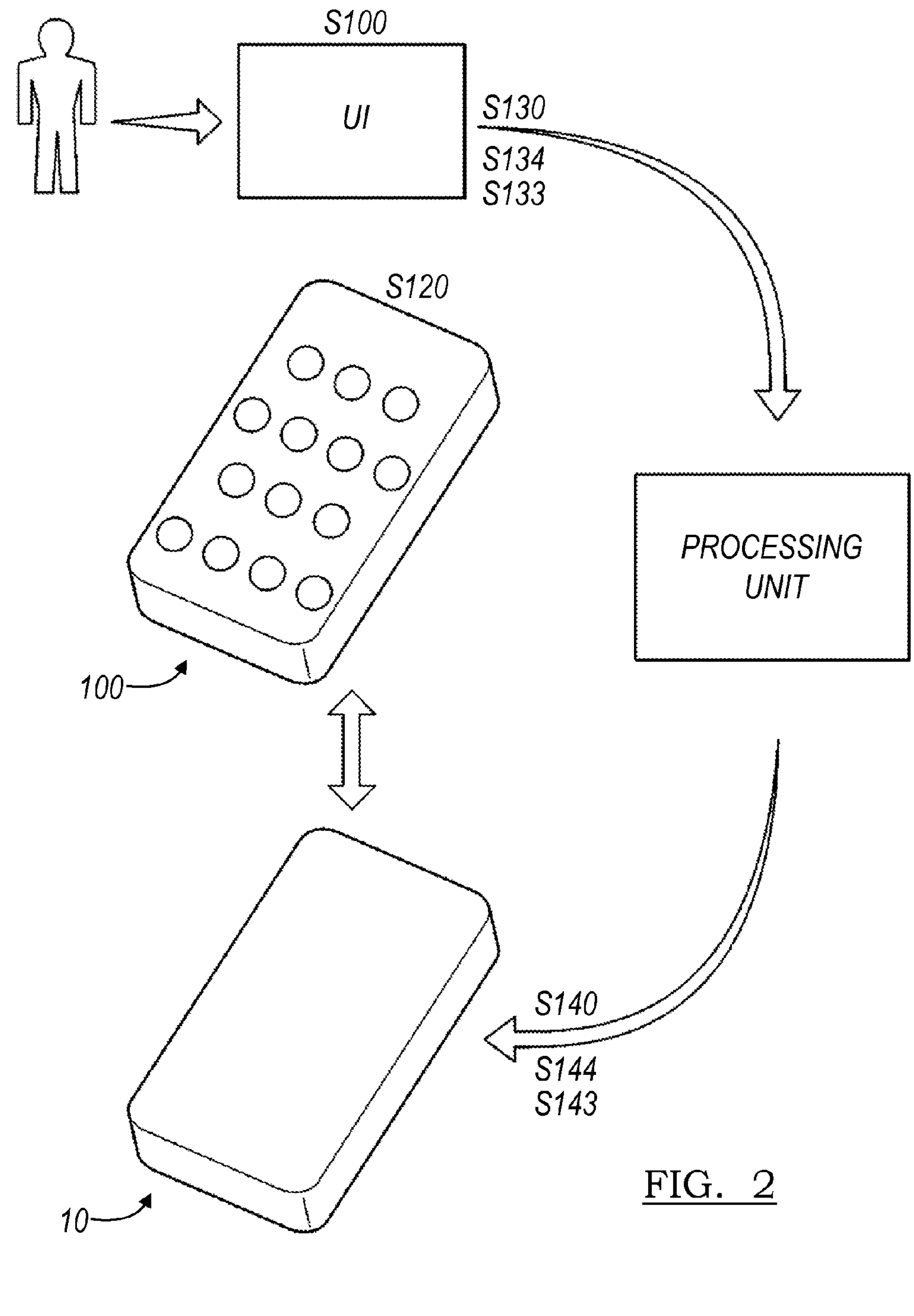

S100
UI
S130
S134
S133
S120
PROCESSING
UNIT
100
S140
S144
S143
10

FIG. 2

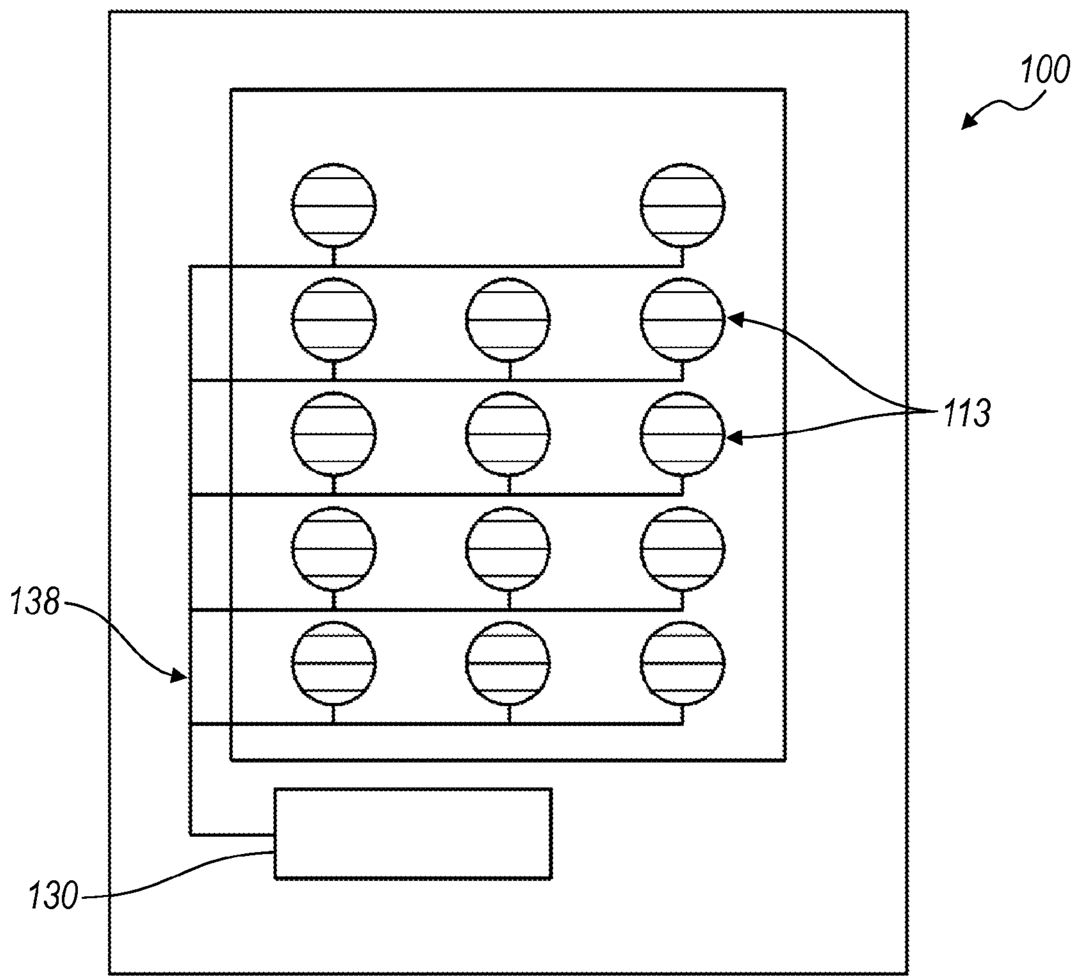


FIG. 3

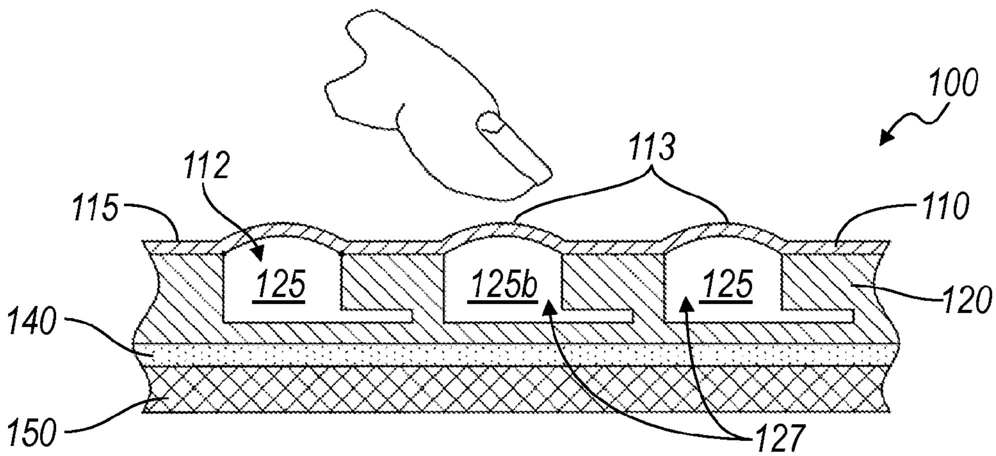

100
113
112
115
110
125
125b
125
120
140
150
127

FIG. 4A

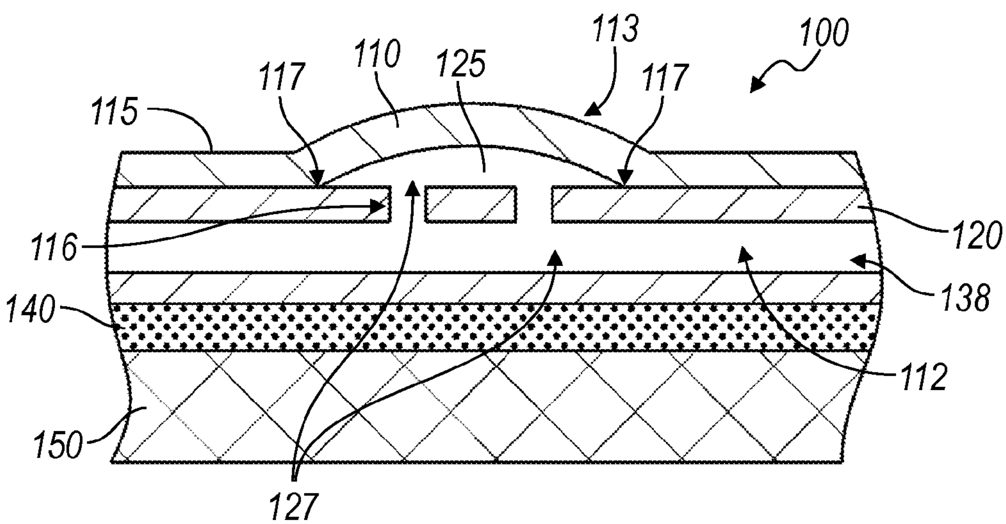

113
100
110
117
125
117
115
116
120
138
140
112
150
127

FIG. 4B

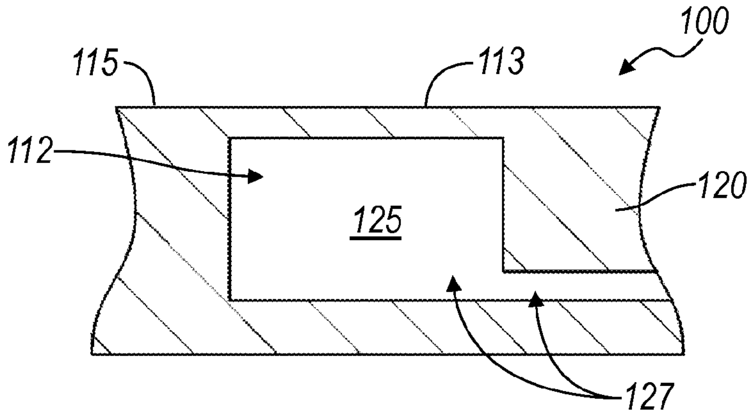


FIG. 5A

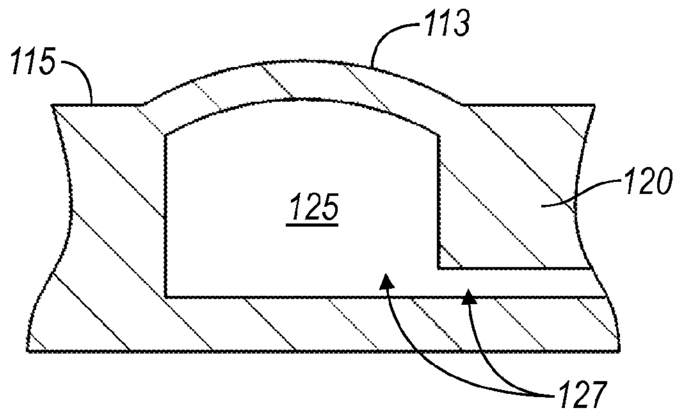


FIG. 5B

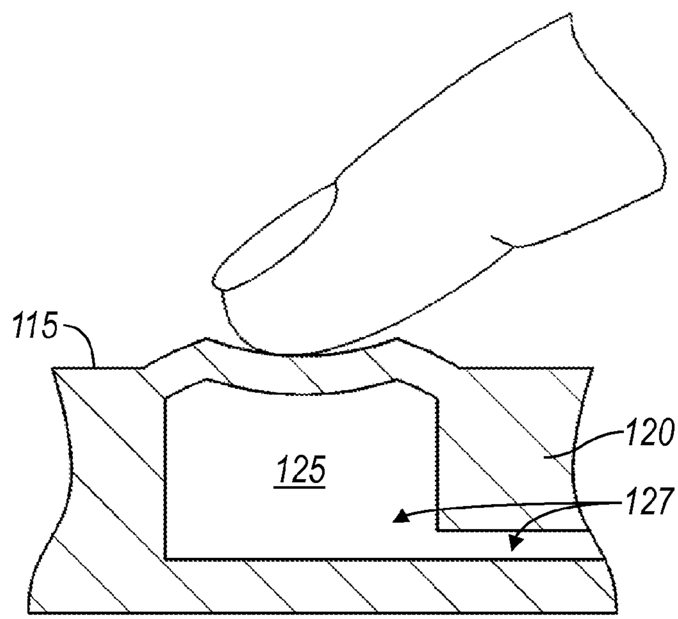


FIG. 5C

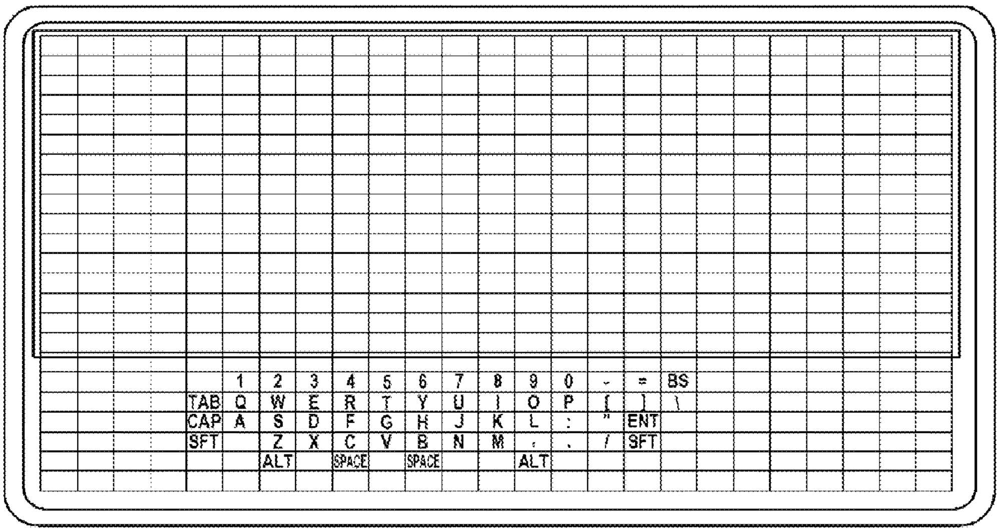

1 2 3 4 5 6 7 8 9 0 - = BS
TAB Q W E R T Y U I O P [ ] \
CAP A S D F G H J K L : " ENT
SFT Z X C V B N M , . / SFT
ALT SPACE SPACE ALT

FIG. 6A

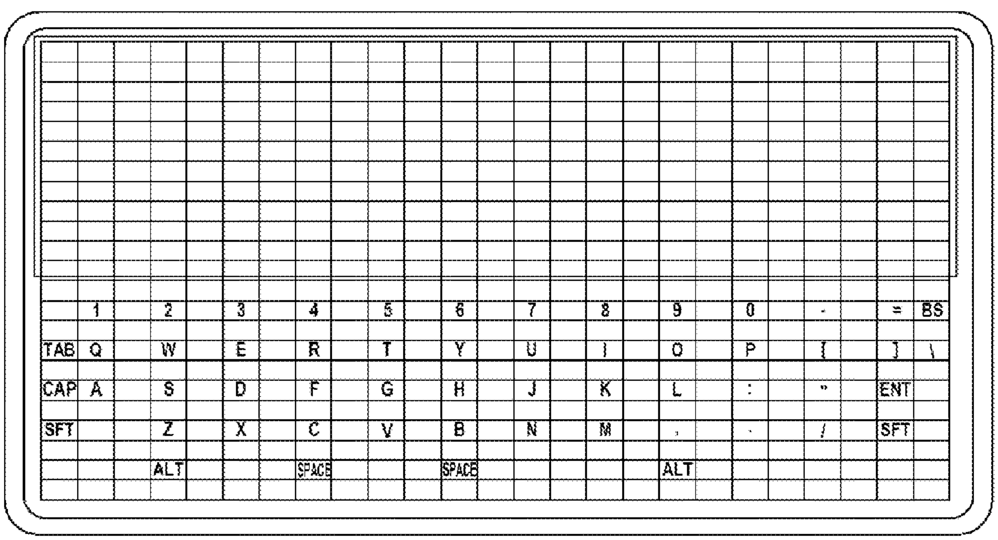

1 2 3 4 5 6 7 8 9 0 - = BS
TAB Q W E R T Y U I O P [ ] \
CAP A S D F G H J K L : " ENT
SFT Z X C V B N M , . / SFT
ALT SPACE SPACE ALT

FIG. 6B

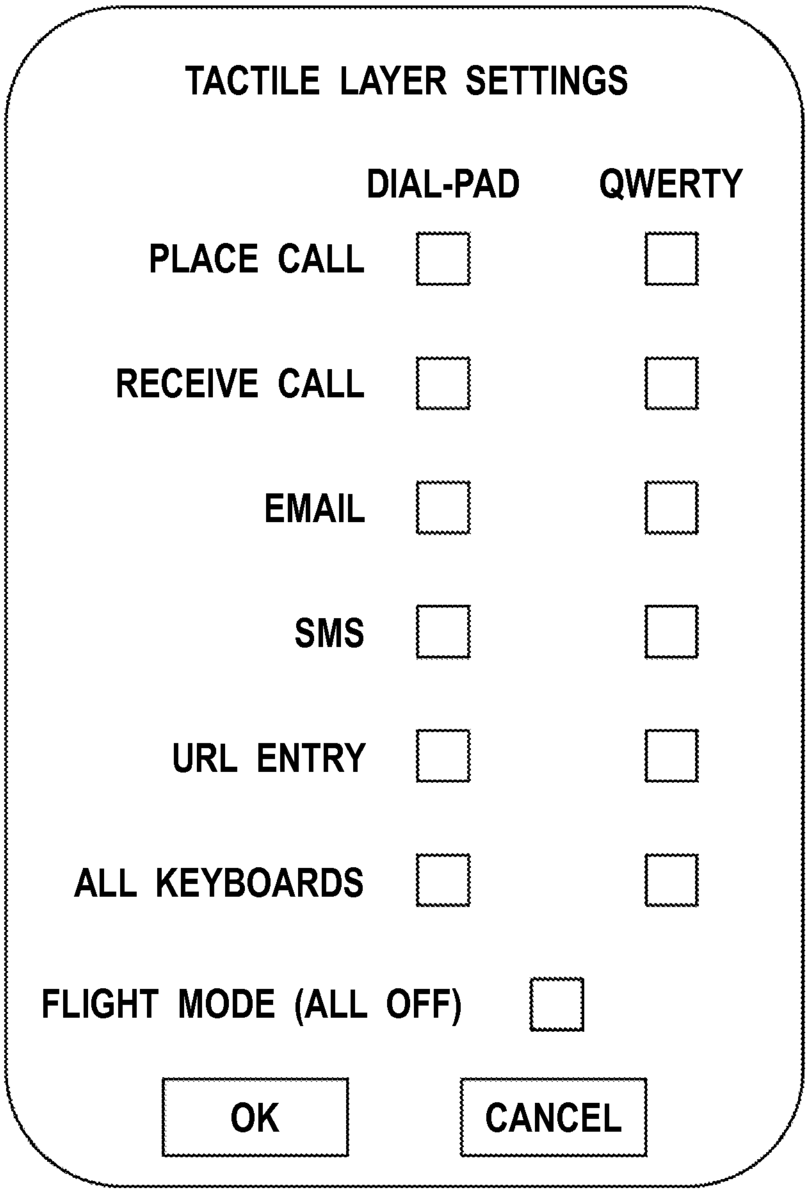

TACTILE LAYER SETTINGS
DIAL-PAD
QWERTY
PLACE CALL
RECEIVE CALL
EMAIL
SMS
URL ENTRY
ALL KEYBOARDS
FLIGHT MODE (ALL OFF)
OK
CANCEL

FIG. 7

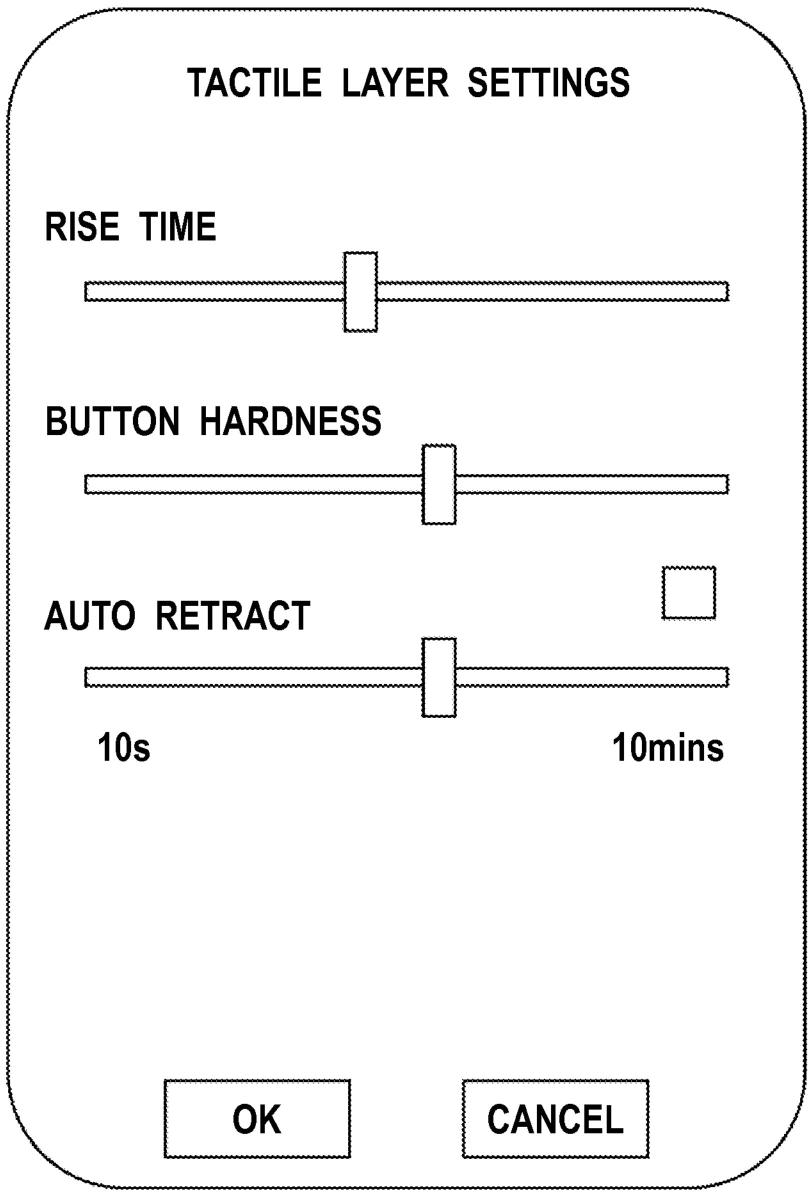

TACTILE LAYER SETTINGS
RISE TIME
BUTTON HARDNESS
AUTO RETRACT
10s
10mins
OK
CANCEL

FIG. 8

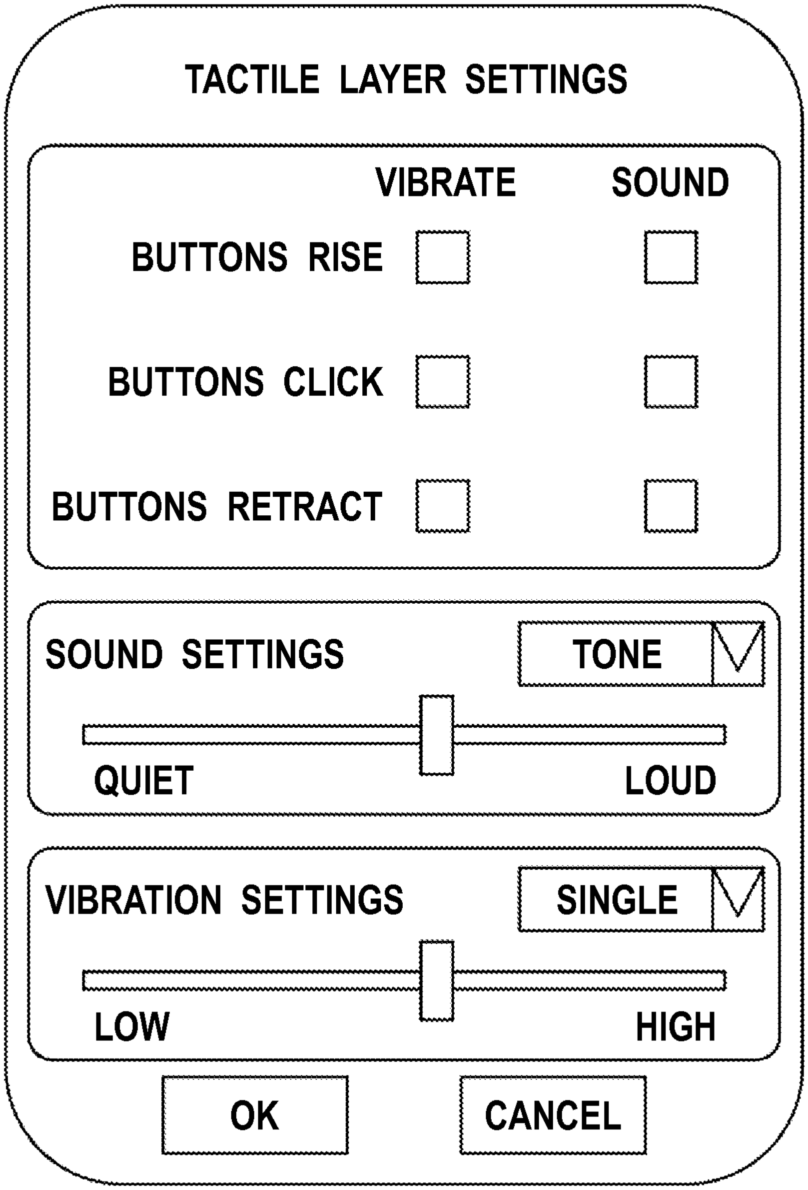

TACTILE LAYER SETTINGS
VIBRATE
SOUND
BUTTONS RISE
BUTTONS CLICK
BUTTONS RETRACT
SOUND SETTINGS
TONE
QUIET
LOUD
VIBRATION SETTINGS
SINGLE
LOW
HIGH
OK
CANCEL

FIG. 9

METHOD FOR ADJUSTING THE USER INTERFACE OF A DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. application Ser. No. 13/465,737, filed 7 May 2012, which is a continuation of U.S. application Ser. No. 12/830,426, filed on 5 Jul. 2010 now issued as U.S. Pat. No. 8,243,038, which claims priority to U.S. Provisional Application No. 61/223,003 filed 3 Jul. 2009 and U.S. Provisional Application No. 61/303,214, filed 10 Feb. 2010, all of which are incorporated in their entirety by this reference.

This application is related to U.S. application Ser. No. 11/969,848, filed on 4 Jan. 2008, and U.S. application Ser. No. 12/319,334, filed on 5 Jan. 2009, which are both incorporated in their entirety by this reference.

TECHNICAL FIELD

This invention relates generally to touch sensitive user interfaces, and more specifically to a new and useful mountable systems and methods for selectively raising portions of touch sensitive displays.

BACKGROUND

The user interface system of U.S. application Ser. Nos. 11/969,848 and 12/319,334 is preferably used as the user interface for an electronic device, more specifically, in an electronic device that benefits from an adaptive user interface. The user interface system functions to provide a tactile guide and/or feedback to the user. Because of the variety of devices and uses that the user interface system may be used for, for example, an automotive console, a tablet computer, a smartphone, a personal navigation device, a personal media player, a watch, a remote control, a trackpad, or a keyboard, the user interface system must accommodate to each application to provide the user with the kind of tactile guide and/or feedback that facilitates the user in the operation of the device **10**. In addition, each user may have a different preference for the kind of tactile guide and/or feedback that is most useful to them in facilitating the operation of the device. For example, while some users may prefer a larger surface area of tactile guidance, others may prefer a larger degree of deformation of the surface area of tactile guidance. Because of the large range of usage scenarios, determining an average user interface system setting that may accommodate to a relatively large range of user preferences for each usage scenario requires a substantial amount of time and research. In addition, because of the large range of user preferences, configuring one set of settings for each use scenario may not provide a user with their preferred tactile guidance and/or feedback. This invention allows the user to adjust the characteristics of the user interface system in order to allow the user interface system to efficiently accommodate to both the usage scenario and the user in a large range of devices and usage scenarios.

BRIEF DESCRIPTION OF THE FIGURES

FIGS. **1** and **2** are a first and second variation of the method of the preferred embodiments, respectively.

FIG. **3** is a top view of the user interface system of a preferred embodiment.

FIGS. **4***a* and **4***b* are cross-sectional views of the tactile interface layer of a first and second variation, respectively.

FIGS. **5***a*, **5***b*, and **5***c* are cross-sectional views illustrating the operation of a particular region of the surface of the tactile interface layer in accordance to the preferred embodiments.

FIGS. **6***a* and **6***b* is a representation of a set of variations to the user interface system.

FIGS. **7**-**9** are examples of input interfaces provided to the user on the device.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The following description of the preferred embodiments of the invention is not intended to limit the invention to these preferred embodiments, but rather to enable any person skilled in the art to make and use this invention.

As shown in FIGS. **1** and **2**, the method S**100** of the preferred embodiments for adjusting a user interface for a device preferably includes providing a user interface to retrieve a user input Step S**110**, providing a tactile interface layer that defines a surface and includes a volume of fluid and a displacement device that manipulates the volume of fluid to deform a particular region of the surface into a tactilely distinguishable formation Step S**120**, retrieving a user preference between a first choice of type, location, and/or timing and a second choice of kind, location, and/or timing through the user interface Step S**130**, and manipulating the volume of fluid to deform a particular region of the surface into a tactilely distinguishable formation of the chosen type, location, and/or timing Step S**140**. The tactile interface layer may also include a sensor that detects a user input at the tactilely distinguishable formation. In this variation, the step of retrieving a user preference S**130** may also include retrieving a user preference between a first sensitivity and a second sensitivity for the sensor through the user interface and the step of manipulating the volume of fluid to deform a particular region of the surface Step S**140** may include manipulating the volume of fluid to deform a particular region of the surface into one of a first embodiment of tactilely distinguishable formation for the first sensitivity for the sensor and a second embodiment of tactilely distinguishable formation for the second sensitivity of the sensor based on the user preference. The step of providing a user interface to retrieve a user input S**110** may include providing a user interface to retrieve a user input on the device, providing a user interface to retrieve a user input on the tactile interface layer, providing a user interface to retrieve a user input that is on both the device **10** and the tactile interface layer, providing a user interface on a remote control for the device **10** (for example, a wireless remote control), or providing a user interface in any other suitable arrangement.

1. Providing a Tactile Interface Layer

As shown in FIGS. **3** and **4**, the tactile interface layer **100** provided in Step S**120** of the preferred embodiment includes: a layer no defining a surface **115**, a substrate **120** supporting the layer no and at least partially defining a fluid vessel **127**, and a displacement device **130** coupled to the fluid vessel **127** that influences the volume of fluid **112** within the fluid vessel **127** to expand and retract at least a portion of the fluid vessel **127**, thereby deforming a particular region **113** of the surface **115**. The surface **115** is preferably continuous, such that when swiping a finger across the surface **115** a user would not feel any substantial seams or any other type of interruption in the surface **115**. Alternatively, the surface **115** may include features that facilitate the user in distinguishing one region from another. The surface **115** is also preferably planar. The surface **115** is preferably arranged in a flat plane, but may alternatively be arranged in a curved plane or on a first plane and then wrapped around to a second plane substantially perpendicular to the first plane, or any other suitable arrangement. The surface **115** may alternatively include lumps, bumps, depressions, textures, or may be a surface of any other suitable type or geometry. The fluid vessel **127** preferably includes a cavity **125** and the displacement device **130** preferably influences the volume of fluid **112** within the cavity **125** to expand and retract the cavity **125**. The fluid vessel **127** may alternatively be a channel **138** or a combination of a channel **138** and a cavity **125**, as shown in FIG. **4***b*. As shown in the variation shown in FIG. **4***b*, the substrate **120** preferably defines a fluid outlet **116** that allows fluid to flow between the channel **138** and the cavity **125** to deform and un-deform a particular region of the surface **113**. The fluid outlet may be formed into the substrate, for example, the fluid outlet **116** may be a series of bores that are machined into the substrate in between the channel **138** and the cavity **125** as shown in FIG. **4***b* or an open orifice between the cavity **125** and the channel **138** as shown in FIG. **4***a*, but may alternatively be a property of the material, for example, the substrate **120** may include a porous material that includes a series of interconnected cavities that allow fluid to flow through the substrate **120**. The substrate **120** may define any suitable number of fluid outlets **116** that are of any suitable size and shape. The tactile interface layer may also include a fluid outlet layer (not shown) that defines the fluid outlets **116** that is separate from substrate **120** and arranged in between the substrate **120** and layer **110**. However, any other suitable arrangement of the fluid outlets **116** may be used. As shown in FIG. **4***b*, the portion of the substrate **120** (or the fluid outlet layer) that includes the fluid outlets **116** may also function to provide a support for the layer no to substantially prevent the layer **110** from substantially depressing into the channel **138** when force is applied over the particular region **113**. However, the substrate **120** may be arranged in any other suitable manner and may provide support for the layer no in any other suitable way.

The layer **110** is preferably attached to the substrate **120** (or fluid outlet layer) at an attachment point **117** that at least partially defines the size and/or shape of the particular region **113**. In other words, the attachment point **117** functions to define a border between a deformable particular region of the surface **113** and the rest of the surface **115** and the size of the particular region **113** is substantially independent of the size of the cavity **124** and/or the channel **138**. The attachment point **117** may be a series of continuous points that define an edge, but may alternatively be a series of non-continuous points. The attachment point **117** may be formed using, for example, adhesive, chemical bonding, surface activation, welding, or any other suitable attachment material and/or method. The method and material used to form the attachment point **117** is preferably of a similar optical property as the layer **110** and the substrate **120**, but may alternatively be of any other optical property. Other portions of the layer no and substrate **120** not corresponding to a particular region of the surface **113** may also be adhered using similar or identical materials and methods to the attachment point **117**. Alternatively, the layer **110** and substrate **120** may be left unattached in other portions not corresponding to a particular region of the surface **113**. However, the layer **110** and the substrate **120** may be arranged in any other suitable manner.

The fluid vessel **127** may also include a second cavity **125***b*. When the second cavity **125***b* is expanded, a second particular region **113** on the surface **115** is preferably deformed. The displacement device **130** preferably influences the volume of fluid **112** within the second cavity **125***b* independently of the cavity **125**, but may alternatively influence the volumes of fluid **112** within both cavity and second cavity **125** and **125***b* substantially concurrently. Alternatively, the user interface enhancement system **100** may include a second displacement device **130** that functions to influence the volume of fluid **112** within the second cavity **125***b* to expand and retract the second cavity **125***b*, thereby deforming a second particular region **113** of the surface. The second cavity **125***b* is preferably similar or identical to the cavity **125**, but may alternatively be any other suitable kind of cavity. The following examples may be described as expanding a fluid vessel **127** that includes a cavity **125** and a channel **138**, but the fluid vessel **127** may be any other suitable combination of combination of cavity **125** and/or channel **138**. The tactile interface layer **100** may also include a display **150** coupled to the substrate **120** and adapted to output images to the user. As described above, the tactile interface layer **100** may also include a sensor **140** that functions to detect inputs from the user. The sensor **140** may be a capacitive sensor, a pressure sensor, a touch sensitive display, or any other suitable sensor type that detects the presence of a user input. The sensor **140** may be located within the fluid vessel **127**, substantially adjacent to the fluid vessel **127** (as shown in FIGS. **4***a* and **4***b*), remote from the fluid vessel **127**, remote from a cavity **125** but fluidly coupled to the fluid vessel **127**, or in any other suitable location.

The tactile interface layer **100** of the preferred embodiments has been specifically designed to be used as the user interface for an electronic device **10**, more preferably in an electronic device **10** that benefits from an adaptive user interface. The electronic device **10** may or may not include a display and/or a touch sensor, for example, an automotive console, a desktop computer, a laptop computer, a tablet computer, a television, a radio, a desk phone, a mobile phone, a PDA, a personal navigation device, a personal media player, a camera, a watch, a remote control, a mouse, a trackpad, or a keyboard. The tactile interface layer **100** may, however, be used as the user interface for any suitable device **10** that interfaces with a user in a tactile and/or visual manner. The tactile interface layer **100** is preferably integrated with the device, for example, in the variation wherein the tactile interface layer **100** includes a sensor **140**, the tactile interface layer **100** is preferably assembled into the device **10** and presented to the user as one unit. Alternatively, the tactile interface layer **100** may function as an accessory to a device **10**, the user may be presented the tactile interface layer **100** and the device **10** as two separate units wherein, when coupled to each other, the tactile interface layer **100** functions to provide tactile guidance to the user and/or to receive user inputs. However, any other suitable arrangement of the tactile interface layer **100** may be used.

As shown in FIG. **5**, the surface **115** of the tactile interface layer **100** preferably remains flat until tactile guidance is to be provided to the user at the location of the particular region **113**. The displacement device **130** then preferably expands the cavity **125** to expand the particular region **113** outward, forming a deformation that may be felt by a user, and providing tactile guidance for the user. The expanded particular region **113** preferably also provides tactile feedback to the user when he or she applies force onto the particular region **113** to provide input. Alternatively, the displacement device **130** may retract the cavity **125** to deform the particular region **113** inward. However, any other suitable deformation of the particular region **113** may be used.

As shown in FIG. **5**, the cavity **125** of the fluid vessel **127** of the preferred embodiment functions to hold a volume of fluid **112** and to have at least two volumetric settings: a retracted volume setting (shown in FIG. **5***a*) and an extended volume setting (shown in FIG. **5***b*). The fluid **112** is preferably a substantially incompressible fluid, but may alternatively be a compressible fluid. The fluid **112** is preferably a liquid (such as water, oil, glycerin, or ethylene glycol), but may alternatively be a gas (such as air, nitrogen, or argon) or any other substance (such as a gel or aerogel) that expands the cavity **125** and deforms the surface **115**. In the extended volume setting, the cavity **125** deforms the particular region **113** of the surface **115** above the plane of the other regions of the surface **115**. When used with a mobile phone device, the deformation of the particular region **113** preferably has a diameter of 2-10 mm and the cavity **125** may be of a substantially equal diameter as the deformation of the particular region **113** or may be of a smaller or larger diameter. When used with this or other applications, however, the cavity **125** may have any suitable dimension.

The displacement device **130** of the preferred embodiment functions to influence the volume of the fluid **112** with the fluid vessel **127** to expand and retract at least a portion of the fluid vessel **127**, thereby deforming a particular region **113** (and/or a second particular region **113**) of the surface **115**. When used with a mobile phone device, the displacement device **130** preferably increases the volume of the fluid **112** within the fluid vessel **127** by approximately 0.003-0.1 ml to expand the cavity **125** to outwardly deform a particular region **113**. When used with this or other applications, however, the volume of the fluid may be increased (or possibly decreased) by any suitable amount. The displacement device **130** preferably modifies the volume of the fluid **112** by (1) modifying the volume of the existing fluid **112** in the fluid vessel **127**, or (2) adding and removing fluid **112** to and from the fluid vessel **127**. The displacement device **130** may, however, influence the volume of the fluid **112** by any suitable device or method. Modifying the volume of the existing fluid **112** in the fluid vessel **127** most likely has an advantage of lesser complexity, while adding and removing fluid **112** to and from the fluid vessel **127** most likely has an advantage of maintaining the deformation of the surface **115** without the need for additional energy (if valves or other lockable mechanisms are used). Although the cause of the deformation of a particular region **113** of the surface **115** has been described as a modification of the volume of the fluid in the fluid vessel **127**, it is possible to describe the cause of the deformation as an increase or decrease in the pressure below the surface **115** relative to the pressure above the surface **115**. When used with a mobile phone device, an increase of approximately 0.1-10.0 psi between the pressure below the layer **110** relative to the pressure above the layer **110**, is preferably enough to outwardly deform a particular region **113** of the surface **115**. When used with this or other applications, however, the modification of the pressure may be increased (or possibly decreased) by any suitable amount.

The shape of the deformation of the particular region **113** is preferably one that is felt by a user through their finger and preferably acts as (i) a button that can be pressed by the user, (2) a slider that can be pressed by the user in one location along the slider or that can be swept in a sliding motion along the slider (such as the "click wheel" of the second generation Apple iPod), and/or (3) a pointing stick that can be pressed by the user from multiple directions and/or locations along the surface whereby the user is provided with tactile feedback that distinguishes a first directional touch from a second directional touch and/or a touch in a first location from a touch in a second location (such as the pointing stick trademarked by IBM as the TRACKPOINT and by Synaptics as the TOUCHSTYK (which are both informally known as the "nipple")). The deformation may, however, act as any other suitable device or method that provides suitable tactile guidance and feedback. In the variation including a display **150**, the shape of the deformation of the particular region **113** also preferably functions to minimize the optical distortion of the image underneath the deformed particular region **113**.

2. Retrieving a User Preference and Manipulating the Volume of Fluid

The user preference retrieved in Step S**130** is preferably one of the following embodiments: a first embodiment for the operation of the tactile interface layer **100**, a second embodiment for interaction between the device and the tactile interface layer, and a third embodiment for operation of the device. The step of retrieving a user preference S**130** of the first embodiment preferably includes retrieving a user preference for the operation of the tactile interface layer Step S**132** and the step of manipulating the volume of fluid to deform a particular region of the surface of the first embodiment S**140** preferably includes manipulating the volume of fluid to deform a particular region of the surface based on the user preference for the operation of the tactile layer Step S**142**. The step of retrieving a user preference S**130** of the second embodiment preferably includes retrieving a user preference for the interaction between the device **10** and the tactile interface layer Step S**134** and the step of manipulating the volume of fluid to deform a particular region of the surface S**140** of the second embodiment preferably includes manipulating the volume of fluid to deform a particular region on the surface based on the user preference for the interaction between the device **10** and the tactile interface layer Step S**144**. The step of retrieving a user preference S**130** of the third embodiment preferably includes retrieving a user preference for the operation of the device Step S**133**. A user preference for the operation of the device may be a user preference for vibrating and/or producing a sound when a particular region **113** is deformed or when a particular application of the device is actuated. Alternatively, a user preference for the operation of the device may include a user preference for the loudness of the sound produced and/or the magnitude of the vibration produced. However, the user preference for the operation of the device may be any other suitable kind of preference for an application of the device.

2.1 User Preference of a First Embodiment

A user preference of the first embodiment may be one of several variations: (i) a preference for the geometry of the deformation (e.g., the size of the deformed particular region **113**), (2) a preference for the tactile feel of the deformation (e.g., the firmness of the deformation), (3) a preference for the performance of the deformation (e.g., the deformation rate of the particular region **113** and/or the time that the particular region **113** is deformed), (4) a preference for the sensitivity of the sensor **140** (for example, sensitivity at the deformed particular region **113**, sensitivity at the un-deformed particular region **113**, or sensitivity for any other suitable state or location along the surface **115**) or (5) a preference for the location of the particular region **113** relative to the tactile interface layer **100**. In the variation of the fluid vessel **127** that includes a second cavity **125***b* that corresponds to a second particular region **113**, a sixth variation may include a preference for which of the particular region **113** and/or second particular region **113** to deform. In the variation of the tactile interface layer that includes a display **150**, a seventh variation may include a preference for a tactilely distinguishable formation independent of the operation of the display **150**. However, any other suitable user preference for the operation of the tactile interface layer may be retrieved through the user interface in Step S**132**.

The volume of fluid may be manipulated in one of several variations to deform a particular region of the surface based on the user preference for the operation of the tactile layer **S142**.

A first variation of manipulating the volume of fluid to deform a particular region of the surface based on the user preference for the operation of the tactile interface layer S**142** preferably includes adjusting the operation of the displacement device **130** and is preferably applied to the first, second, and/or third variation of a user preference of the first embodiment. In particular, adjusting the operation of the displacement device **130** is preferably used to adjust the geometry, tactile feel, and performance of the deformation of the particular region **113**. As mentioned above, the cause of the deformation of the particular region **113** may be thought of as an increase in the pressure below the surface **115** relative to the pressure above the surface **115**. The displacement device **130** functions to provide this increase in pressure by modifying the volume of fluid **112** within the cavity **125**. For example, the level of increase in the volume of fluid **112** within the cavity **125** directly influences the level of increase of the pressure below the surface **115**, and by changing the level of increase in pressure below the surface **115** relative to the pressure above the surface **115**, characteristics such as the firmness and the height of the deformation of the particular region **113** may be adjusted. The rate of increase of the pressure below the surface **115** relative to the pressure above the surface **115** may also affect the rate at which the deformation of the particular region **113** occurs. Similarly, the length of time that the displacement device **130** provides the increased pressure is directly related to the length of time that a particular region is deformed. By providing adjustments through varying the operation parameters of the displacement device **130** in this first variation, the number of available adjustment settings is directly related to the number of available variations in the operation parameters of the displacement device **130**. For example, in adjusting the firmness of the deformation of the particular region **113**, the tactile interface layer **100** may provide a minimum firmness and a maximum firmness with a substantially large number of firmness level settings in between the minimum and maximum firmness, each correlating with a volume increase within the cavity **125** that a displacement device **130** of the first variation may induce or a volume of fluid **112** that a displacement device **130** may provide. This may provide the user with the ability to apply an adjustment setting that is substantially close to their personal preference. The number of available settings may be less than the number of available variations in the operation parameters of the displacement device **130** to decrease complexity. However, any other suitable number of adjustment settings may be provided to the user.

In another example of the first variation, adjusting the operation of the displacement device **130** may be applied to the fifth variation of the user preference of the first embodiment where the user provides a preference for the location of the particular region **113** relative to the tactile interface layer **100** and/or the sixth variation where there is a second cavity **125***b* and the user provides a preference for which of the particular region **113** and/or second particular region **113** to deform. In particular, the displacement device **130** may function to selectively expand the cavity **125** and/or the second cavity **125***b* corresponding to a particular region **113** that is indicated in the user preference. The user may select one particular region from a first and a second particular region that they desire to be expanded to provide tactile guidance in a certain user scenario. Alternatively, there may be a plurality of cavities **125** and second cavities **125***b* that are arranged into a first group and a second group. In an example of a user selection for a particular usage scenario, the first group may include a first spacing in between each particular region **113** of the first group and the second group may include a second spacing in between each particular region **113** of the second group, as shown in FIGS. **6***a* and **6***b*. A user may prefer the second spacing (for example, a larger spacing) and select to expand the second group during use. The displacement device **130** then functions to expand the second group for the particular usage scenario. Any other variations to the operation parameters of the displacement device **130** may be used to adjust the characteristics of the first embodiment of the tactile interface layer **100**.

A second variation of manipulating the volume of fluid to deform a particular region of the surface based on the user preference for the operation of the tactile interface layer S**142** preferably includes adjusting the deformation of the particular region **113** to set a user preference of the fourth variation for the sensitivity of the sensor **140**. For example, the sensor **140** may be a capacitive sensor that detects the presence of the finger of the user at a distance away from the surface **115**. To decrease the sensitivity of the sensor **140**, the height of the deformation of the particular region **113** may be increased such that, when the finger of the user is resting on the top of the deformed particular region **113**, a user input is not registered. In other words, the equivalent sensitivity of the sensor may be decreased while the actual sensitivity of the sensor remains the same. Alternatively, the sensitivity of the sensor **140** may be adjusted by adjusting the operation of the sensor **140**. In one example, the thresholds for the sensor **140** to register a user input may be adjusted. In the variation wherein the sensor **140** is a touch sensitive display, a touch at any location along the display may register as a user input regardless of the presence of a particular region **113**, preventing the user from resting their finger on a deformed particular region **113** as a user would normally be able to do on a static tactile interface such as those found on a remote control with mechanical buttons or a Blackberry mobile phone. In this variation, the user may input a user preference for a lower sensitivity for the sensor **140** wherein a user input is registered only if the finger is at a certain distance away from the touch sensitive display, preferably one wherein the distance is less than the distance between the most distant point of the deformation of the particular region **113** from the surface **115**, allowing the user to rest their finger on the deformation and the sensor **140** only registering a user input when the deformation is inwardly deformed by force applied by the user. In the variation wherein the sensor **140** is a capacitive or a pressure sensor, the sensitivity of the sensor **140** may be adjusted such that a user input is registered with a certain degree of change in capacitive or pressure reading. However, any other suitable adjustment to the sensitivity of the sensor **140** may be provided to the user.

In another example of adjusting the operation of the sensor **140**, readings from the sensor **140** may be ignored and/or the sensor **140** may be disabled. In the variation wherein the sensor **140** is a touch sensitive display, certain portions of the touch sensitive display may be disabled and/or readings from certain portions of the touch sensitive display may be ignored. For example, for certain usage scenarios, the particular region **113** that is deformed may be on a first portion of the touch sensitive display. The user may input a user preference to disable the remaining portions of the touch sensitive display to prevent undesired touch inputs, but may alternatively allow the remaining portions of the touch sensitive display to continue to receive touch inputs, allowing the user to select options that are displayed in a location wherein the particular region **113** is not deformed. However, any other suitable combination of ignored readings, disabled sensing, and/or enabled sensing may be used.

A third variation of manipulating the volume of fluid to deform a particular region of the surface based on the user preference for the operation of the tactile interface layer S**142** preferably includes manipulating the volume of fluid to deform a particular region of the surface independently of the state of the display **140** and is preferably applied to the seventh variation of a user preference of the first embodiment to set a user preference for a tactilely distinguishable formation independent of the operation of the display **150**. For example, the user preference may include disabling the display **150** while enabling the sensor **140**. Subsequently, the volume of fluid is manipulated to expand a particular region of the surface. Because the tactile interface layer **100** provides tactile guidance, the visual guidance provided by the display **150** is not necessary in certain scenarios to guide the user in the user of the device **10**. Disabling the display **150** allows the device **10** to conserve energy, potentially extending the use time per charge of the device **10** if the device **10** is a portable device such as a camera or a cellular phone.

The user preferences for the operation of the tactile interface layer **100** retrieved in Step S**132** are preferably one of the variations as described above but may alternatively be any other suitable combination of or any other kind of user preference for the operation of the tactile interface layer **100**. The volume of fluid is preferably manipulated in Step S**142** using a system or method described above, but may alternatively be a combination of the systems and/or methods described above or any other suitable system or method.

2.2 User Preference of a Second Embodiment

A user preference for the interaction between the device and the tactile interface layer retrieved in Step S**132** may also be of one of several variations. In a first variation, the user preference of the second embodiment may be a preference for the location of the particular region **113** relative to the device **10**. For example, the user may indicate the location of the particular region **113** relative to the device **10** that best fits the size of his or her hand. In a second variation, the tactile interface layer **100** may include a second cavity **125***b* that corresponds to a second particular region **113**, and the user preference of the second embodiment may be a preference for the location of a particular region **113** relative to another particular region **113**. For example, the displacement device **130** may manipulate fluid to deform a plurality of particular regions **113** into tactilely distinguishable formations that cooperatively represent a keyboard layout and the user preference may be a preference for the relative location between the keys of the keyboard, as shown in FIGS. **6***a* and **6***b*. By allowing the user to provide a preference for the relative location between the keys of the keyboard the tactile interface layer **100** is substantially customized to each individual user, which may increase the usability of the keyboard and may potentially decrease the risk of repetitive stress syndrome.

A third variation of a user preference of the second embodiment may include a preference for the timing for the actuation of a deformation. As an example, the user preference may include the preference for actuation of a deformation when a particular application of the device is actuated. The tactile interface layer **100** may define a plurality of particular regions **113** that cooperatively represent a numeric keypad and device **10** may include a phone application and the user preference may be to actuate the deformation of the plurality of particular regions **113** when the phone application is actuated. In another example, the displacement device **130** may manipulate fluid to deform a plurality of particular regions **113** into tactilely distinguishable formations that cooperatively represent a QWERTY keyboard and the device **10** may include a typing application and the user preference may be to actuate the expansion of the QWERTY keyboard when the user initiates a typing application. In yet another example, the displacement device **130** may manipulate fluid to deform a plurality of particular regions **113** into tactilely distinguishable formations and the user preference may include a preference for the actuation of the deformation of a particular tactilely distinguishable formation at a particular timing. The plurality tactilely distinguishable formations cooperatively represent a keyboard and the user preference preferably includes a preference for a tactilely distinguishable region representing a particular key.

The user preference for interaction between the device **10** and the tactile interface layer **100** retrieved in Step S**134** is preferably one of the variations as described above but may alternatively be any other suitable combination of or any other kind of user preference for the operation of the device **10** and/or interaction between the device **10** and the tactile interface layer **100**.

The volume of fluid is preferably manipulated in Step S**144** using a system or method described above for the step of manipulating the volume of fluid to deform a particular region of the surface Step S**142**, but may alternatively be a combination of the systems and/or methods described above or any other suitable system or method. The manipulation of the fluid is preferably actuated by a processing unit of the device **10**, for example, actuating the expansion of the desired cavity **125** during certain usage scenarios such as incoming phone calls on a phone. However, any other suitable interaction between the device **10** and the tactile interface layer **100** may be used.

3. Providing a User Interface

As described above, the user interface provided in Step S**110** to retrieve a user input may be provided on the tactile interface layer **100**, which may allow the user to have a direct tactile comparison between different available settings for the tactile interface layer **100**; on both the device **10** and the tactile interface layer **100**, which may allow the device **10** and the tactile interface layer **100** to cooperatively provide a user interface for the user; on the device **10**; or in any other suitable arrangement. The device **10** and/or the tactile interface layer **100** preferably enters a "customization mode" wherein the user is prompted to provide inputs for user preferences that preferably do not register as any other kind of input. The user interface tactile, visual, audible, or in any other suitable kind of media.

In a first variation of the user interface, the interface is provided on the tactile interface layer **100**. In a first example of the user interface of the first variation, the user interface may provide a plurality of expanded cavities **125** and/or **125***b* that result in a plurality of deformed particular regions **113** on the tactile interface layer **100**, wherein each of the plurality of deformed particular regions **113** is of a different characteristic such as a different degree of firmness and/or a different shape. The user then selects the particular region **113** that best fits their preferences and the selection is detected by the sensor **140** and sent to a processing unit in the tactile interface layer **100** and/or a processing unit in the device **10**.

In a second example of the first variation, the user interface may provide a deformed particular region **113** in the form of a slider on the tactile interface layer **100**. The slider may include a plurality of regions, each region representing a different degree of a characteristic such as firmness, size, and/or distance between deformations. The user may slide their finger along the slider to experience the various degrees of the characteristic and select the desired degree. The selection may be inputted by providing force at the location along the slider of the degree they select, but may alternatively be a selection inputted adjacent to the slider or any other suitable location or kind of input.

In a third example of the first variation, the user interface may provide a deformed particular region **113** in the form of a slider and another particular region **113** in the form of an "example region" on the tactile interface layer **100**. The user may adjust the position of the slider to adjust the option for adjustment demonstrated by the "example region." The user may tactilely feel the example region as they adjust the slider and then select their desired adjustment. The slider is preferably of a uniform characteristic to decrease the tactile variations felt by the user and to potentially decrease confusion, but may alternatively emulate the adjustment demonstrated by the example region to allow the user to tactilely feel the adjusted characteristic on more than one location or shape of deformed particular region.

In a fourth example of the first variation, the user interface may provide a deformed particular region **113** that transitions in between different degrees of a characteristic such as firmness, or size and the user selects the desired degree. The transitions are preferably cyclic and repeat the range of degrees for the user to experience as many times as necessary before making a selection. The user may input the selection as the deformed particular region **113** is demonstrating the various available options, but may alternatively input the selection after the deformed particular region **113** has demonstrated the available options. The rate of demonstration by the deformed particular region **113** is preferably at a slow rate to allow the user to adequately examine the option for their decision, but may alternatively be an adjustable rate or any other suitable rate.

In a fifth example of the first variation, the user interface may provide a plurality of cavities **125** that may correspond to, for example, a keyboard layout. A plurality of cavities **125** is expanded and a plurality of deformed particular regions of the surface **113** is presented to the user. The user may then select the set of deformed particular regions of the surface **113** that best fit their hand shape for a particular application as described in the second variation of a user preference of the second embodiment retrieved in Step S**134** and as shown in FIGS. **4***a* and **4***b*. In the example of a keyboard layout, the user may select the set of deformed particular regions that best match their hand size and shape, allowing for a more personalized keyboard layout for each individual user, potentially decreasing the risk of repetitive stress disorder that may result from arranging the hand of the user in an uncomfortable and stressful position. In the example of the keyboard layout, the user may be presented with a plurality of options for the location of the deformed particular region that corresponds to each keyboard key. The options for the location of each key may be presented concurrently with the options for every other key in the keyboard, but may alternatively be presented to the user one after the other. However, any other suitable method to allow the user to select their desired location of each key may be used. Once the location of each key is determined, the user may then be prompted to select the desired height and/or firmness of each key, allowing the user interface system to accommodate to the natural angle of the user's hands, further decreasing the potential of repetitive stress syndrome.

In a second variation of the user interface, the user interface is provided on the device **10**. This variation is particularly applicable in retrieving a user preference for the interaction of the device and the tactile interface layer S**134**. The user interface as provide on the device **10** is preferably applied to a device **10** that includes a display **150** that provides an image to communicate to the user, but may alternatively be applied to any other suitable kind of device, for example, a device that includes a speaker to communicate with the user, or a device that provides a vibration to communicate with the user. In a first example of the second variation of the user interface, as shown in FIG. **7**, the user interface may provide a series of check boxes where the user may choose options for the actuation of the deformation of the particular region **113** (such as to retrieve a user preference for the actuation of a deformation in the third variation of the user preference of the second embodiment). As shown in FIG. **7**, the user may select to actuate the deformation of the particular region **113** when the "place call," "receive call," "email," etc, application of the device **10** is actuated. Additionally, the user may provide a preference for the arrangement of the particular region **113** that is to be deformed, for example, a QWERTY keyboard or a numeric keypad.

In a second example of the second variation, as shown in FIG. **8**, the user interface may provide an interface on the device **10** that allows the user to provide a preference for the operation of the tactile interface layer **100**. In other words, a user interface to retrieve a user preference for the operation of the tactile layer **100** (the first embodiment of user preference) may be provided on the device **10**. This example of the second variation of the user interface may function similarly to the second and third example of the user interface of the first variation that provide a slider on the tactile interface layer **100**.

In a third example of the second variation, as shown in FIG. **9**, the user interface may provide an interface on the device **10** that allows the user to provide a preference for the operation of the device, for example, vibrating and/or producing a sound when a particular region **113** is deformed or when a particular application of the device is actuated. This is particularly applicable to retrieving a user preference for the operation of the device in Step S**133**.

In a fourth example of the second variation, the user interface may allow the user to select the desired location for a particular region. For example, in the variation where the device **10** includes an application which uses a keyboard, the user interface may prompt the user to select the desired location for each key in a keyboard instead of providing options to the user for the location of each key in the keyboard. The user may alternatively be asked to place the fingers of their hand in the most natural position onto the tactile interface layer **100**. The location of each finger is detected and the cavity **125** and particular region of the surface **113** that is substantially adjacent to the location of the finger is then selected as the location of the keyboard key.

In a third variation of the user interface, the user interface may be is provided on a device that is external to both the device **10** and the tactile interface layer **100**. For example, the user interface may be provided an application on the Internet, on a personal computer, or any other suitable medium.

The user interface of the preferred embodiments is preferably one of the variations described above, but may alternatively be a combination of the variations described above. For example, the user interface may provide a slider on the device **10** that functions to control the characteristic of an "example region" on the tactile interface layer **100**, allowing the device **10** and the tactile interface layer **100** to cooperatively provide a user interface to the user. The device may also provide a visual indicator (for example, a numerical level setting) that indicates the level of a particular setting. This may facilitate in communicating setting options to the user. However, any other suitable user interface may be used.

As shown in FIGS. **1** and **2**, a processing unit retrieves a user preference that is provided by the user on the user interface S**130** and sets the user preferences to the operating conditions S**140**. The processing unit may actuate the manipulation of the volume of fluid based on the user preferences to the operation of the tactile interface layer S**132**, the operation of the device S**133**, and/or the interaction between the device and the tactile interface layer S**134**. In a first variation, the processing unit may be included into the tactile interface layer **100** and may also function to control the displacement device **130**, sensor **140** and/or the display **150**. The processing unit may communicate directly with the components of the tactile interface layer **100** (e.g. the displacement device **130**, but may alternatively communicate with the components of the tactile interface layer **100** in any other suitable manner. The processing unit of this first variation may function to communicate with a processing unit of the device **10** to receive signals representing user selections.

In a second variation, the processing unit may be included into the device **10** and may also function to control the applications of the device **10**. The processing unit of this second variation may communicate directly with the components of the tactile interface layer **100** (e.g. the displacement device **130**), but may alternatively communicate to the components of the tactile interface layer **100** in any other suitable manner. The processing unit of this second variation may communicate with the components of the tactile interface layer **100** through a wired communication protocol, a wireless communication protocol, or any other suitable kind of communication protocol.

In a third variation, the processing unit may be external to both the tactile interface layer **100** and the device **10**, for example, a personal computer that is communicably coupled to the tactile interface layer **100** and/or the device **10**. In this variation, when the user desires to provide and/or apply user preferences to operating conditions, the device and/or the tactile layer **100** may be connected to a personal computer that may include an interface that allows the user to provide a user preference.

The processing unit of the preferred embodiments is preferably one of the variations as described above, but may alternatively be any combination of the above variations. For example, the tactile interface layer **100** may include a processing unit that functions to control the tactile interface layer **100** and the device **10** may include a processing unit that functions to control the device **10**. The processing units of the tactile interface layer **100** and the device **10** may function to communicate with each other to provide control for an operating condition. In this variation, the processing unit of the tactile interface layer **100** may communicate with the processing unit of the device **10** through a wired communication protocol, a wireless communication protocol, or any other suitable kind of communication protocol. However, any other suitable arrangement of the processing unit may be used.

As a person skilled in the art will recognize from the previous detailed description and from the figures and claims, modifications and changes can be made to the preferred embodiments of the invention without departing from the scope of this invention defined in the following claims.

We claim:

1. A method, for adjusting a user interface of a computing device, comprising:

displaying a range of parameter levels between a minimum parameter level and a maximum parameter level for a button rise time;

receiving a parameter level selection from the range of parameter levels;

receiving a retract time selection from a range of retract times between a minimum retract time and a maximum retract time;

rendering an input graphic on a display of the computing device;

correlating the parameter level selection with a rate of fluid displacement for the button rise time;

displacing a volume of fluid into a cavity arranged over the input graphic on the display at the rate of fluid displacement to expand a deformable region corresponding to the input graphic from a retracted setting into an expanded setting, the deformable region flush with an adjacent peripheral region in the retracted setting and offset above the peripheral region in the expanded setting;

displacing fluid, at a second flow rate, out of the cavity to retract the deformable region from the expanded setting into the retracted setting, wherein displacing fluid out of the cavity comprises displacing fluid out of the cavity at the second flow rate corresponding to the retract selection; and

sensing an input on the deformable region.

2. The method of claim **1**, further comprising receiving a button firmness level selection from a range of button firmness levels between a minimum button firmness level and a maximum button firmness level, and wherein displacing the volume of fluid into the cavity comprises displacing the volume of fluid corresponding to the button firmness level selection into the cavity.

3. The method of claim **2**, wherein displacing the volume of fluid into the cavity comprises displacing fluid into the cavity until a fluid pressure within the cavity reaches a target fluid pressure corresponding to the button firmness preference.

4. The method of claim **1**, further comprising receiving a button height selection from a range of button heights between a minimum button height and a maximum button height, and displacing the volume of fluid into the cavity to expand the deformable region according to the button height selection.

5. The method of claim **4**, wherein displacing the volume of fluid into the cavity comprises correlating the button height preference with a target fluid volume between 0.003 milliliters and 0.1 milliliters and displacing the target fluid volume into the cavity.

6. The method of claim **1**, further comprising receiving a button size selection from a range of button sizes between a minimum button size and a maximum button size; wherein displacing the volume of fluid into the cavity comprises displacing the volume of fluid corresponding to the button size selection into the cavity.

7. The method of claim **1**, further comprising displaying a second input graphic on the display, the second input graphic different from and adjacent the input graphic, and further comprising displacing a second volume of fluid into a second cavity arranged over the second input graphic on the display at a rate corresponding to the parameter level selection for the button rise time to expand a second deformable region corresponding to the second input graphic from a retracted setting into an expanded setting, the second deformable region flush with an adjacent peripheral region in the retracted setting and offset above the peripheral region in the expanded setting.

8. The method of claim **7**, wherein displacing the second volume of fluid into the second cavity comprises displacing the volume of fluid into the cavity and the second volume of fluid into the second cavity substantially simultaneously, the volume of fluid and the second volume of fluid substantially equivalent.

9. The method of claim **7**, wherein displaying the input graphic on the display and displaying the second input graphic on the display comprise displaying a virtual alphabetical keyboard on the display, the input graphic and the deformable region corresponding to a first alphabetical character and the second input graphic and the second deformable region corresponding to a second alphabetical character.

10. The method of claim **1**, wherein sensing the input on the deformable region comprises detecting a degree of change in capacitance of a capacitive touch sensor proximal the deformable region and correlating the degree of change in capacitance with an input on the deformable region.

11. The method of claim **1**, wherein displacing the volume of fluid into the cavity comprises actuating a pump fluidly coupled to the cavity for a duration of time corresponding to the parameter level selection for the button rise time.

12. A method for adjusting a user interface of a computing device comprising:

displaying a range of parameter levels between a minimum parameter level and a maximum parameter level for a button rise time;

receiving a parameter level selection from the range of parameter levels;

receiving a retract time selection from a range of retract times between a minimum retract time and a maximum retract time;

displaying a input graphic on a display of the computing device;

displacing fluid, at a flow rate corresponding to the parameter level selection for the button rise time, into a cavity arranged over the input graphic on the display to expand a deformable region corresponding to the input graphic from a retracted setting into an expanded setting, the deformable region flush with an adjacent peripheral region in the retracted setting and offset above the peripheral region in the expanded setting;

displacing fluid, at a second flow rate, out of the cavity to retract the deformable region from the expanded setting into the retracted setting, wherein displacing fluid out of the cavity comprises displacing fluid out of the cavity at the second flow rate corresponding to the retract time selection; and

sensing an input on the deformable region.

13. The method of claim **12**, further comprising receiving a button size selection from a range of button sizes between a minimum button size and a maximum button size; wherein displacing the volume of fluid into the cavity comprises displacing the volume of fluid corresponding to the button size selection into the cavity.

14. A method for manipulating a tactile interface layer comprising a tactile layer, a substrate, and a displacement device, the tactile layer defining a deformable region and a peripheral region, the substrate defining a fluid channel and a cavity adjacent the deformable region and fluidly coupled to the fluid channel, the displacement device manipulating fluid through the fluid channel into the cavity, the method comprising:

displaying a range of parameter levels between a minimum parameter level and a maximum parameter level for a button height;

receiving a parameter level selection for a button height from the range of parameter levels;

receiving a retract time selection from a range of retract times between a minimum retract time and a maximum retract time;

rendering an input graphic on a display of the computing device substantially aligned with deformable region;

correlating the parameter level selection with a particular displacement volume of fluid;

defining a retracted setting of the deformable region substantially planar with the peripheral region and a maximum expanded setting offset from the peripheral region and tactilely distinguishable from the peripheral region, the maximum expanded setting substantially corresponding to the maximum parameter level;

displacing the particular displacement volume of fluid into the cavity to expand a deformable region corresponding to the input graphic from the retracted setting into a particular expanded setting corresponding to the parameter level selection; and

displacing fluid, at a second flow rate, out of the cavity to retract the deformable region from the expanded setting into the retracted setting, wherein displacing fluid out of the cavity comprises displacing fluid out of the cavity at the second flow rate corresponding to the retract time selection.

15. The method of claim **14**, wherein displacing the particular displacement volume of fluid into the cavity comprises displacing fluid into the cavity until a fluid pressure within the cavity reaches a target fluid pressure corresponding to the parameter level selection.

* * * * *